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AMERICAN EDUCATION

BY DEXTER S. KIMBALL

President of the Society

In this age of criticism when all educational institutions and particularly those of the higher order are being examined critically and often denounced as inefficient, antiquated and wholly inadequate to the needs of our growing civilization it is cheering to some of us who have long endured these tirades to have a gleam of light gild the surrounding gloom. Most of us can look back to the time when a man to "complete" his education perforce journeyed to France, Germany or England. This idea still prevails in the minds of some, the outstanding illustration of this notion being found in the Rhodes Scholarships. The writer would be the last to decry the benefits of study in a foreign university, but nevertheless it may be of interest to note that a change is coming in this connection that should be encouraging to all who believe in American educational methods as illustrated in our great universities, admitting readily the long gap between the ideals of these methods and the actual realization even in the best of them. The writer would not asume to offer his own opinions on this matter but does not hesitate to quote the following by Dr. Stephen P. Duggan, Director of the Institute of International Education and one who speaks with authority in such matters.

In the *News Bulletin* of the Institute for December, 1928, Dr. Duggan speaking of the industrial difficulties of England, makes the following statement:

"The seriousness of the crisis is known to every intelligent Englishman, and the British Government of to-day is turning for counsel more and more to the classes of the population engaged in industry, commerce and finance, and less and less to the landed gentry, who form, indeed, a slowly disappearing element of the population. The former classes need intelligence trained in specific directions and are finding it in con-

stantly increasing measure in the so-called provincial universities, institutions which in the United States would be called municipal universities. Although the provincial universities teach the humanities, the emphasis of their instruction is on the sciences and the applied sciences at that. Moreover, each of them gives special attention to those branches of science that would be of most service in assisting the industries of the municipality in which it is situated. In this respect they resemble many of our state universities."

"Down to the Great War, the Government of the British Empire was in the hands of the graduates of Oxford and Cambridge, men educated primarily, sometimes almost solely, in the humanities. A large proportion of them were the sons of the gentry, the clergy, and the professional classes. More and more, however, are the graduates of the provincial universities entering into the vocations upon which Government in the future will lean for aid and counsel. Inevitably, therefore, will the provincial universities play a more important part in the life of Great Britain. The old universities will probably never lose the place of prestige which tradition and service in the past have assigned to them. But they are now losing the monopoly which they formerly enjoyed of supplying leaders to the life of the nation and as time passes they will necessarily have a lessened influence in controlling the affairs of the nation."

No better or sounder appreciation of the Morrill Act has ever been written nor has there been a clearer endorsement of American education as illustrated by our great universities. Truly "all knowledge is for use" and the people that most fully conquers its environment will eventually reach the highest average level intellectually and physically. American education is making headway and Dr. Duggan's remarks should give us fresh enthusiasm.

THE OHIO STATE UNIVERSITY

S. A. HARBARGER

Department of English

The Ohio State University is located at Columbus, the capital of the state, which has a population of approximately 300,000. Three and one half miles from the center of the city —up North High Street on the west side—is the campus of the University. In 1871 when the University was established, it was on the edge of the city; but now the city has grown around it and extended far north. It is a university in a city.

Like all others founded upon the Morrill Act of 1862, The Ohio State University was organized as an agricultural and mechanical college. Indeed, the act of the Ohio legislature creating the university, March 22, 1870, provided for "a college to be styled The Ohio Agricultural and Mechanical College." The location of the new school was the subject of much discussion; but early in 1871, a farm of 331.1 acres was purchased on what was then the north edge of Columbus, "reasonably central in the state and accessible by railroads from different parts thereof." More land has been acquired since 1871, until now the University owns 1,150 acres. The original campus still remains as such; in fact, most of the present college buildings are located upon it. The additional land has been purchased for the University farm which is operated in conjunction with the College of Agriculture. In so large a university, it is rather unusual to have all of the college located upon one campus. Such, however, is the case at The Ohio State University, for the colleges of Agriculture, of Commerce and Administration, of Dentistry, of Education, of Engineering, of Law, of Liberal Arts, of Medicine, of Pharmacy, of Veterinary Medicine, and the Graduate School are all on the same campus.

The first college building, University Hall, is still being used for classes and some administrative offices. There are

AIRPLANE VIEW OF THE CAMPUS, THE OHIO STATE UNIVERSITY

PRESIDENT GEORGE W. RIGHTMIRE
The Ohio State University

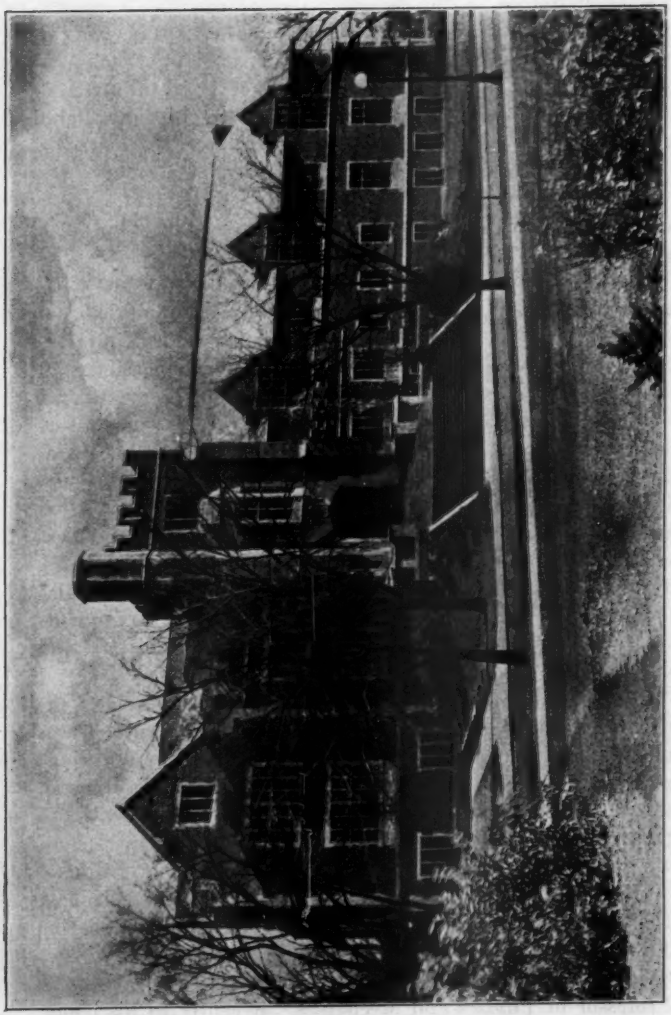
AIRPLANE VIEW OF THE CAMPUS, THE OHIO STATE UNIVERSITY

UNIVERSITY HALL, THE OHIO STATE UNIVERSITY

now 70 buildings on the campus; a new one, the Chemistry building, is just being completed, and another, old chemistry, is being remodeled for all the language departments,—English, modern foreign languages, Latin and Greek. In the Administration Building, a comparatively new one, the first and second floors are given over to offices of the President, the Bursar, the Registrar, the University Examiner, and other executives; the third floor, to the Faculty Club for the faculty and administrative officers. Such a centralized meeting place gives an opportunity for the faculty to mingle from day to day, as well as furnishes a convenient place for staff and committee meetings. The University Library contains 275,000 volumes. In addition, there are smaller specialized libraries elsewhere on the campus. Among them is the Orton Memorial Geology Library said to be finest of its kind in the United States. This library is the gift of General Edward Orton, Junior, in memory of his father, Edward Orton, first President of The Ohio State University and Professor of Geology. In Pomerene Hall are centered the women's activities. Here are the women's department of physical education, the offices of the Dean of Women, the Y. W. C. A. and student affairs. The Ohio State Historical and Archæological Building, also located on the campus, offers unusual opportunity for students with little effort to gain an appreciation of the history and development of their state.

The "broad gauge" idea of education was the basis of the first course of study though in the beginning instruction was offered only in: agriculture, mathematics and engineering; physics and mechanics; chemistry; geology, mining and metallurgy; ancient language and literature. At the present time the work of the several colleges is carried on in 75 departments with 2,500 courses and a great variety of curricula leading to 33 degrees. It is interesting to note that T. C. Mendenhall, President of the Society for the Promotion of Engineering Education when the society held its annual meeting at Ohio State thirty years ago—1899—was on this first faculty as Professor of Physics and Mechanics. Recently in his honor, the Physics laboratory has been named the Mendenhall Lab-

UNIVERSITY HALL, THE OHIO STATE UNIVERSITY



POMERENE HALL, THE OHIO STATE UNIVERSITY

ORTON HALL, THE OHIO STATE UNIVERSITY

POMERENE HALL, THE OHIO STATE UNIVERSITY

oratory of Physics. Dr. William Henry Scott, the father of Charles F. Scott, Chairman, Board of Investigation and Coordination, and Past President of the S. P. E. E., was the third President of The Ohio State University.

When the college opened its doors to students in September, 1873, 17 enrolled, but by the end of the year there were 50. The new college developed rapidly, and by 1878, when the name was changed to The Ohio State University, it had 309 students and the faculty had been increased from 7 to 12. Today, 56 years after, the students number about 14,000 and there is a permanent teaching staff of 546 and temporary and part-time assistants numbering 174. In this same period, there have been more than 20,000 graduates, more than half of whom have received their degrees in the last ten years; for in the past ten years there has been an unprecedented increase in attendance. At the present time, The Ohio State University ranks seventh in size among all American universities, and fifth among the state universities.

The "broad gauge" idea of education upon which the first course of instruction was based, has been continued and developed. The university is becoming more and more the educational center of the State. Not only is it serving by training the young men and women, but also through its extension divisions, laboratories, research bureaus it is giving assistance to business, to agriculture, to professions and to industries of the State of Ohio.

*EDUCATIONAL PROCESSES AS EMPLOYED IN THE DEPARTMENT OF ELECTRICAL ENGINEERING AT THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY

BY J. W. BARKER AND R. H. FRAZIER

I. Introduction: Educational Ideals of the Department

The forerunner of the Department of Electrical Engineering at the Massachusetts Institute of Technology was an option in Applied Electricity established in the Department of Physics in 1882. This option was developed by the Department of Physics over a period of twenty years until 1902 when the present Department of Electrical Engineering was formed.

On account of the long period of evolution in the Department of Physics the courses in Electrical Engineering have inherited a strong mathematical-physics basis. This basis has been maintained and strengthened, and is today the central feature about which the educational ideals of the Department of Electrical Engineering are clustered. However, great emphasis is given also to illustration and testing of theory by the solution of problems and by work of investigative character in the laboratories.

In so far as is practicable an effort is made to secure instruction in the engineering subjects taught to electrical engineering students by other departments on substantially the same plan as mentioned above. Furthermore considerable weight is attached to the understanding and application of the principles of economics, not only as a general subject under the Department of Economics and Statistics, but in connection with the work of the engineering subjects. Since students who choose a course in Electrical Engineering naturally are apt to give their best attention to the electrical subjects, an especial effort is made to persuade the students of the im-

* Presented at the 36th Annual Meeting of the Society, Chapel Hill, N. C., June 26–29, 1928.

portance of the so-called "non-electrical" subjects to the electrical engineer.

In common with students in all courses, the students in the courses in Electrical Engineering are required to devote a moderate amount of time to studies of a general nature. This amount of time is slightly greater than the median time devoted to Humanistics in all the Electrical Engineering Courses as shown in the Bulletins of the Board of Investigation and Coordination of the Society for the Promotion of Engineering Education. While the broadening value of liberal studies is fully recognized, it is maintained that ambitious men can and will obtain this by their own reading and study, and furthermore that to attempt any great degree of liberalizing by compulsory subjects is futile. No amount of liberal studies can compensate for the training in exact reasoning acquired from the study of mathematics and the physical sciences wherein the results can be verified. When students thoroughly schooled in these latter subjects turn their attention to more general matters, the conclusions reached are more apt to be sound than those of the "liberally" educated. In fact, there is no profession which furnishes a breadth of experience equal to that of engineering. The older liberal education has ceased to be the broader one; education in the sciences has become fundamental. Therefore in order that the students' time may be used most advantageously the general subjects are designed primarily for the creation of curiosity and the indication of the direction in which it may be satisfied.

At this point it seems interesting to quote a portion of an address made by Francis Amasa Walker, then President of the Massachusetts Institute of Technology, at the Technology Alumni Dinner in New York City in 1896. President Walker spoke in part as follows:

"The Massachusetts Institute of Technology, as you know, gentlemen, was founded upon several fundamental and far-reaching beliefs.

"First, a belief in the essential manliness of young men, a belief that, if they are properly appealed to, if they have subjects presented to them deserving of their attention and best

efforts, they will respond in the spirit, not of trying to find how little they can do and how poorly they will be allowed to do it, but how much they can do and how well they can do it.

"Secondly, a belief that the study of scientific principles directed straight upon practice of a worthy profession, constitutes the best kind of education, that education which leads to the most fortunate development of intellect and character, of mind and manhood, altogether in addition to its merits as a preparation for professional success.

"Thirdly, a belief that scientific principles, acquired in the recitation and lecture rooms, should be constantly applied to field and laboratory work. It was this conviction which at the outset dictated the foundation of the laboratory of general chemistry and the laboratory of general physics, of applied mechanics, of metallurgy, of steam and of hydraulic and mill engineering.

"Fourthly, a belief that, in addition to scientific and technical studies and exercises, which tend to make men resolute, exact and strong, there should be given, in every such school at least a moderate amount of those philosophical and cultural studies and exercises which tend to make men also broad and liberal."

The educational ideals of the Department of Electrical Engineering of course incorporate those of the Institute as a whole; however there are certain practices and ideals which are more peculiar to particular departments. For the Department of Electrical Engineering the most important of these are the provisions for the orientation of the students with respect to the curriculum and its bearing on future work; for the development of pride in the history and standards of the engineering profession, together with an understanding of the present-day conditions of engineering employment; for the combination of theoretical and practical training by co-operation with engineering concerns; and for the adaptation of rate of work and method of instruction to the individual mental speeds of students, including the plan for Honors Groups.

The various features of the electrical engineering curricula now will be explained and discussed with more or less detail. It is not claimed that the individual features are original with

the Department, or the Institute. Furthermore it is probable that other institutions accomplish certain of these features with admirable effectiveness. However it is believed that the Department here referred to is more or less unique in the success with which these various features have been incorporated and coordinated in engineering education to form a well-balanced structure on the mathematical-physics foundation.

II. Details of the Electrical Engineering Curricula

The original four years course in Electrical Engineering founded in 1902 and known as Course VI has been supplemented by the cooperative five years options established at intervals since 1919 and known collectively as Course VI–A, and the resident communications option branching from Course VI with the junior year which was established in 1922 and is known as Course VI–C. The outline and discussion of subjects and methods of instruction which follows is primarily from the point of view of their bearing on the curriculum of Course VI. Such important differences as exist for Course VI–A or Course VI–C will be indicated. The features of the cooperative courses were presented to the Society in 1927.*

The general layout of the subjects of instruction can be understood best by a study of the schedules in tabular form.† The subjects for the specific teaching of which the Department of Electrical Engineering is responsible are the Principles of Electrical Engineering, Electrical Engineering Laboratory, Principles of Electrical Communications, Electrical Communications Laboratory, the professional electives, theses, and of course the graduate subjects of the Department. It may be mentioned in passing that the junior year Mathematics, which

* "Cooperative Courses at the Massachusetts Institute of Technology," W. H. Timbie, Professor of Electrical Engineering and Industrial Practice, *Jour. of Eng. Education*, New Series, Vol. XVIII, No. 4, Dec., 1927. (Presented at the 35th Annual meeting of the Society at the University of Maine, June 27–30, 1927.)

† See the Institute Bulletin relative to the Department of Electrical Engineering, 1928 issue, pp. 48–53.

deals with differential equations related to electricity, the Electromagnetic Theory and the Electromagnetic Wave Propagation, Sound, Speech and Audition, and the senior year English which is mentioned later, originally were established either in, or at the instigation of, the Department of Electrical Engineering. Furthermore it should be mentioned that there are certain electrical subjects taught to students in the so-called non-electrical courses.

The subject, Principles of Electrical Engineering, about which the courses in Electrical Engineering are built, extends from the middle of the sophomore year through the senior year and includes the following divisions: fundamental laws of the electric, dielectric, and magnetic circuits; direct-current machinery; theory of alternating currents; alternating-current machinery; and electric power transmission and distribution. Throughout these divisions of the subject the emphasis is upon principles and not upon details of design or practice. Instruction is given by means of two to four class hours per week, a weekly one or two hour problem section, assigned practice problems, laboratory work (closely correlated therewith and referred to in more detail later) and term examinations. Each of the five divisions of the subject mentioned above is in charge of a professor especially qualified in that division, under whom is a group of about five members of the staff, depending upon the number of class sections to be taught.

The students are divided originally among sections of about twenty men or less in accordance with their observed relative mental speeds. The number of students handled by the department and the size of the staff makes it possible to have say six such sections in a class, placing three sections, a fast, an intermediate, and a slow section all on one set of hours on the schedule and another similar group on another set of hours. This arrangement then makes possible the transfer during the term of a student from a fast to a slower section or vice-versa without disturbing his registration in other subjects and at the same time provides for irregularities of students' schedules and the substitution of instructors.

The original separation of the students into the various

sections is based on a study of their prior records in Mathematics and Physics. After this initial selection at the beginning of the second term of the sophomore year the students are watched closely as to performance in class room discussions and in the weekly problem sections. Except for clear cut cases of mistakes in sectioning, no changes are made until about five weeks have passed. During this time doubtful cases are discussed in the weekly subject conference of staff and whenever it becomes evident that a student differs greatly from the average mental speed of his section he is moved either to a faster or a slower section as seems advisable. This process is continued throughout the term, but care is taken that changes are not made at such frequent intervals as to prevent that intimate contact between student and instructor for which the Department strives. Also, frequent changes of the individual might produce an undesirable effect upon him due to possible discontinuities in manner of presentation of the subject matter. Following the initial division in Principles of Electrical Engineering the final sectioning in the preceding division becomes the initial sectioning of the succeeding division. Changes in sectioning due to misfits become less and less frequent for succeeding divisions of the subject.

Once a week the teaching staff assigned to a division has a conference with the professor in charge of that division for the purpose of discussing progress and educational methods, discussion of particular students as outlined above, mapping out of work and choice of problems.

The scope of the work in all the sections is the same, but the method of treatment is quite different. In the slow section the textbook is adhered to rather rigidly and explained; there is considerable of drill and repetition. A large number of illustrative problems are used. Mathematical work is supplemented by the use of descriptive matter for the purpose of creating clearer mental pictures. In the fast section the textbook is not touched upon very much by the instructor except in so far as special questions pertaining thereto are raised. It is assumed that on the whole the students in the fast section are able to master the textbook without much aid and

have time to spare. In this section therefore, the work is more highly mathematical; collateral sources of information are suggested to the students and are used by the instructor; problems of more than usual difficulty are proposed in class or are assigned to certain students for solution and discussion. The object is to deepen the understanding and strengthen the grasp of the subject, rather than to increase the range of subject matter. In intermediate sections the method of treatment is intermediate between that for the slow and that for the fast sections. The students of all sections in a division attend the same problem sections and term examination.

The weekly problem sections and term examinations are designed to test the ability of each student to set up the mathematical equations which represent the relations of the data given in the statement of the problem, to solve these equations and to interpret in physical terms the results obtained. In many cases the problems involve principles of economics or mechanics in addition to principles of electricity and magnetism. These problem sections furnish the student with a means by which he can evaluate his progress.

There are ordinarily no definite rules in connection with the number of assigned practice problems required or in connection with class attendance. Not much attention is paid to the number of practice problems solved by high standing students, but the failure of low standing students to hand in major portions of the assigned practice problems may be looked upon as an indication of neglect of work and may be used as the basis for a choice of the lower mark in a borderline case at the end of the term, and the assignment of an extra set of problems. In general, except in the case of honors students mentioned later, regular class attendance is expected, though ordinarily no rigorous attendance records are kept. The classes are small enough for the instructors to keep in mind the approximate regularity of attendance. No particular investigations are made except in cases of persistent absence. There is no cut system.

It is believed that the process outlined is producing very good results. While there are certain criticisms of the prac-

tice of sectioning on the basis of mental speed, these are felt to be of minor importance. The system as used in the Department of Electrical Engineering at the Massachusetts Institute of Technology has proved to be a stimulus to students and a great aid to instruction. In the case of students handled for the course of Electrochemical Engineering whose electrical instruction is substantially parallel to, though more abbreviated than, that for Course VI, the Principles of Electrical Communications for Course VI–C, and sometimes in connection with Course VI–A, the groups are too small to sectionalize. However in the latter cases it makes less difference from the point of view of instruction because each group already is mentally of relative homogeneity.

Equal in educational value to the series of divisions classed as Principles of Electrical Engineering is the work in the Electrical Engineering and Electrical Communications Laboratories. The former has two divisions, that of electrical measurements and that of electrical machinery. The work in these divisions approximately parallels the theoretical work in Principles of Electrical Engineering while the Electrical Communications Laboratory serves a similar purpose with respect to Principles of Electrical Communications.

Except for special cases, instruction is accomplished by means of assigned experiments for which general instructions are given in the form of notes and references. Although the general subject matter of the theoretical subject and the general assignment of the corresponding laboratory parallel one another, no special attempt is made to ensure that the student has had theoretical instruction covering a certain type of apparatus before performing an experiment with that apparatus. It is believed that this encourages a truly investigational attitude and stimulates the research spirit.

Arrangements commonly are made for students to work in pairs. Before each experiment in the laboratory it is expected that the students will familiarize themselves with the theory involved, inspect the apparatus assigned, and devise a method of procedure. In most cases these matters are incorporated in preliminary reports which are read by members

of the laboratory staff and passed upon in conference with the students before approval is given to draw instruments and start experimental work. This is particularly true where faulty procedure may result in considerable damage to apparatus or personal danger. During the performance of the experimental work the students purposely are given a minimum of aid by the members of the laboratory staff who, however, do observe the procedure to a certain extent and when necessary check over connections. After the experiment or investigation has been performed, the students bring the data sheets to a member of the laboratory staff for criticism and signature. The students then have one week in which to prepare a final report in which the results are submitted and discussed. These final reports are read and criticized by members of the laboratory staff and further conferences held with the individual students when necessary.

The laboratory staff also confers weekly for the purpose of discussing questions which arise in connection with the instruction. In some instances instructors are assigned to both class room and laboratory instruction and when practicable are on laboratory duty during the hours when their class room students are performing experiments. This arrangement has seemed advantageous to both students and instructors.

Every effort is made to maintain the work of the laboratories on a quantitative investigational basis. The emphasis is placed upon the illustration of principles rather than upon the teaching of standard commercial tests. The apparatus is not permanently connected in standard sets but is to a very large degree in separate mobile units capable of being utilized in many ways. Pieces of equipment are to a considerable extent of commercial types and sizes, frequently with special taps or auxiliary windings but not having abnormal characteristics, but these are supplemented by apparatus of modified or special design, perhaps originally intended for some particular research. It is believed that this system stimulates greater interest and originality, exercises powers of adaptation and improvisation, develops greater resourcefulness and power of observation, and consequently serves the purpose of

illustrating principles better than could be secured by the performance of routine tests.

The courses in Electrical Engineering culminate in theses in the last year. In course VI–A one thesis of graduate caliber is required. The theses are in general of the nature of experimental investigation or research, though occasionally primarily mathematical or economic. In the performance of the thesis, a student is under the supervision of a staff advisor, but on the whole is expected to attack his problem with relatively little direct aid in order that he may demonstrate how thoroughly he has mastered the principles and acquired the qualities of mind which the methods of instruction are designed to impart and develop.

An extension of the system of sectionalizing for mental speed previously referred to is represented by the Honors Groups, the first of which was established in 1925 for the Class of 1927. A new group has been established for each subsequent class beginning with the junior year. Thus since the formation of the second group there have been two groups in existence simultaneously, one in the junior year, and one in the senior year. It is aimed to make the number in each not over twenty-five men, though the actual number varies in accordance with the number of students in the class who have appropriate qualities. Applications for membership in the Honors Group of their class are received from students during the second term of the sophomore year. The members of the group are chosen toward the end of the sophomore year largely on the basis of previous records in Mathematics, Physics, Chemistry and Applied Mechanics, and the record in Principles of Electrical Engineering to the time of selection. The opinions of various members of the staff with regard to the intellectual capacity, resourcefulness, sense of responsibility, and seriousness of purpose of each candidate also are considered in the selection. Students may be admitted to the Honors Group of their class at the end of any term when the improvement in their work has been such as to make their total record worthy of consideration, though the admission of students after the beginning of the senior year is very improbable; college trans-

fer students with promising previous records may be admitted to the Honors Group of their class on the basis of a high record for one or two terms at the Institute. Students may be dropped from the Honors Group at the end of any term on account of not having maintained records of the standard desired.

The plan upon which the Honors Groups are based can be explained most readily by incorporating the information sheet prepared for the students:

"Within the scope and ideals of the curriculum the plan for the Honors Groups provides greater independence of study to the students in the groups than is characteristic of the usual practice of the Institute and therefore includes the following features:

"1. The students in the groups are privileged to attend the class exercises of the regular subjects or not, as they individually please; but are expected to pass with distinction the usual term examinations, which should be accomplished successfully as a result of the special reading proposed.

"2. Of practice problems assigned to the classes, the honors students are privileged to work out such number as they individually please, but each is encouraged to spend time over the details of only those that illustrate principles new to him, thus avoiding loss of time by any unnecessary repetition. All are expected to do the work in the regular weekly electrical engineering problem sections and to attend all previously announced written quizzes in all subjects.

"3. The laboratory work of each term which usually consists of a series of specific assignments, consists for each Honors Group in the electrical engineering laboratories of a general assignment relating to the principles of construction and the characteristics of the circuits, instruments and machinery treated during the term, with the specific problems and method of work thereon largely determined by the interest of each individual student, who carries on under the advice and direction of the General Counselor referred to below. The students are encouraged to carry on all laboratory work as far as practicable as individual investigations of the principles and applications under consideration, directed along paths of their own interests in the subject. The usual electrical engineering laboratory reports are omitted and the report for each student consists of his notebook containing an outline of his plan for the term, the record of his various investigations and measure-

ments, his comments, and a brief summing up toward the end of the term of his accomplishments and progress during the term. His progress is observed from this notebook during the term.

"4. Honor students who become interested in a particular investigation, even as early as the junior year, that may be developed into a thesis project, may substitute this for the larger part of the usual electrical engineering laboratory work, provided that it is of sufficient scientific breadth.

"5. Freedom from existing restrictions of scheduled class hours and laboratory hours affords opportunity for more reading and study related to the subjects of the curriculum. In order that the students' progress may be orderly and any difficulties encountered may be faced courageously and overcome, General Counselors are available in this department for conference from time to time, one for the students of each group, and a special Conferee is available from the staff of each of the other departments in which students of the groups take subjects. Substitution of subjects in the curriculum is permitted to accommodate particular tastes and interests of honors students, provided that these substitutions do not carry the student too far afield. Such substitutions may be secured by approval of the Head of the Electrical Engineering Department. It is essential for the student to realize that in exercising his freedom he is expected to use his time in reasonable accord with the general policy outlined.

"6. For the purpose of stimulating the groups to the scholarly thoughtfulness regarding their careers that is needful for distinguished leadership in Electrical Engineering, near the end of his senior year each honors student is expected to present to his counselor and conferees an oral statement of his progress and accomplishments during the junior and senior years, with comments on his grasp of the electrical engineering field and its collaterals.

"7. Candidacy for the two annual Swope Fellowships in Electrical Engineering, carrying grants respectively of $1,000 and $500 in support of a year's graduate work in this country or in Europe, is confined to honors students.

"The features outlined above necessitate each honors student's wholehearted acceptance of the responsibility of planning and carrying out effectively his method of study. This individual acceptance of responsibility is fundamental to the success of the Honors Group plan. Each honors student is his own taskmaster and must substitute his personal interest and discipline for the compulsion of the daily assignment. When

entering the Honors Group each student should appreciate that this lesson of self-administration is at once a difficult and a valuable lesson to learn. The members of the Department Staff always are ready sympathetically to extend suggestions and advice regarding the progress of study."

It should be understood that the regulations outlined apply to electrical engineering course students in all subjects, except those taught to cooperative students at the works, whether taught by the Department of Electrical Engineering or by other departments, though the Honors Group plan has not been adopted by other departments except in a limited way.

There is a General Counselor for each of the two Honors Groups who continues with the same group for the two years of its existence. The duties of the counselors are primarily to assist the students with uncommon difficulties arising in connection with the various subjects of instruction, to stimulate them to independent and original work, to aid in the effective planning of their time, to suggest collateral reading which will amplify and correlate the subjects of instruction, besides a moderate amount of general cultural reading, to instill an enthusiastic attitude toward studies and future work by discussing and explaining the ideals of the Department and the conditions of engineering employment and practice, to encourage pride in personal appearance and habits, to learn something of each student's family life and social setting, and to keep familiar with their progress and methods of work. In order to facilitate contact with the students, each counselor is provided with an attractively furnished conference office.

The experience indicates that in the junior year Honors Group there is apt to be, particularly during the first term, a slight decrease in the level of academic records for a portion of the group, with perhaps a few rather poor records. This probably is due to the period of readjustment to new conditions of work and to a few inappropriate selections. An effort is being made to remedy this by making the fast sections in sophomore Principles of Electrical Engineering rather definitely preparatory to honors study. However, the men who have carried through to the senior year honors study have

attained remarkable records, with a very few exceptions, and have shown evidence of very superior development. The results therefore are satisfactory. The statement of progress mentioned in paragraph six of the outline of the plan for honors study, in June 1928, took the form of a trial comprehensive examination which most of the honors students took voluntarily and in which they performed quite well. It is possible that sometime in the future a system of required comprehensive examinations may be introduced for the honors students and greater freedom granted from term examinations and quizzes.

The Swope Fellowships have proven a real stimulus to scholarship. In 1927–1928 twelve of the thirty honors students in the senior year group were applicants.

Graduate Study in the Department of Electrical Engineering is on a basis the ideals of which were presented to the Society in 1927.* Therefore the matter will not be dwelt upon in detail in this paper. The instruction is very largely on an individual basis and centers about research, the value of which is recognized not only as a means for the acquisition of new knowledge, but as a means of creating an atmosphere of curosity and investigation infectious to undergraduates. There are no definite subject requirements † with the exception of the Electrical Engineering Seminar, which is designed to familiarize the students with the history and progress of Electrical Engineering, to furnish the background for research, and to give training in the participation in meetings similar to those of the engineering societies. A particular aid to this and to research in general is the valuable Vail Library of Electrical Engineering, one of the most notable libraries on the subject in the world.

Students who enter the Massachusetts Institute of Tech-

* "Graduate Study in the Engineering Schools," Dugald C. Jackson, Head of the Department of Electrical Engineering, Massachusetts Institute of Technology. *School and Society*, Vol. XXVI, No. 669, Oct. 22, 1927. (Address to the Division of Deans and Administrative Officers at the 35th Annual Meeting of the Society at the University of Maine, June 27–30, 1927.)

† See the Institute Bulletin on Graduate Study and Research.

nology receive no official advice relative to the choice of a course, other than that which they seek themselves, until the second term of the first year, when various department heads point out the features of the different courses in a series of lectures especially announced for the purpose. Shortly thereafter the various department heads keep office at certain hours for several successive weeks for the express purpose of being available for interview to first year students.

On suggestion from the Department of Electrical Engineering, the Student Branch of the American Institute of Electrical Engineers has established a few evening lectures primarily for first and second year students by representatives of the cooperating companies of Course VI–A. These lectures deal with the character of work in four different electrical engineering activities; manufacturing; communications; design and construction of plant; and management of electric power, electric railway and gas utilities. These lectures have been very well attended and have served to orient many first year students concerning some of the fields of Electrical Engineering.

In the second term of the sophomore year, in the Department of Electrical Engineering a series of fourteen correlated lectures is given by members of the Institute faculty from several departments, aimed to acquaint the students with the ideals of the Department of Electrical Engineering, the characteristics of its curriculum, and the interrelations of the subjects of instruction. Likewise in the second term of the junior year is given a series of fourteen lectures, mostly by members of the faculty of the Department of Electrical Engineering, dealing with the relations of scientific discovery to engineering, the relations of engineering to society, the characteristics of engineering industries and their forms of organization, and the relations and duties of young engineers toward their associates. Attendance at none of these lectures is compulsory. The series in the junior year may be altered in scope after the institution of the Chair of Humanics referred to later.

In order to demonstrate more fully the relationship of the scientific character of the curriculum to actual engineering

activities, a series of Colloquia * has been established to which all graduate and senior year electrical engineering students, and junior year honors students are invited. Many staff members attend also.

Each Colloquium is led by either one or two men, invited from industry, who are essentially masters in their particular branch of work for their company and are recognized as such in the electrical engineering field. Each such leader is sufficiently advanced in the work so that he is not too closely confined to details, that is, his daily work is not on actual details but is of a somewhat supervisory nature so that he conceives broadly the development and practice in his branch; but his work is not purely administrative and so far away from execution that he does not continue in touch with details. Heads of engineering and like departments of industry or professional practice fulfill the specifications.

The plan is for each Colloquium to be held for a period of two successive days. The leader or leaders are asked to arrive in Boston so as to be available during the forenoon of the first day to look over the department setting, get acquainted with the members of the staff if not already acquainted, learn the details of the instruction and characteristics of the equipment of the Department, and get an insight into the preparation of the students who probably will attend the Colloquium.

The Colloquium *per se* begins in the afternoon of the first day. Two consecutive hours are assigned to it on each day. During these periods the leader or the two leaders alternately, present (1) the science underlying the particular subject with which the Colloquium deals, (2) the way in which that science has been developed, with special emphasis on the part that may have been developed through the research and practice of his own company, but of course, with due consideration of what has been done elsewhere and by others, (3) the way in which the particular speaker is in the habit of applying the science as he conceives it in the practice for his company, with such comparisons as may be appropriate with the applications, (4) the

* See the Institute Bulletin on the Department of Electrical Engineering, 1928 issue, p. 14.

gaps in the science which make it necessary to fortify practice by purely empirical methods, associated with a clear statement of the manner of establishing empirical formulas and the like, (5) a statement of such empirical formulas and the speaker's interpretation of the relations of these empirical methods to the known science, and finally (6) the speaker's conception of the advantages which might be derived from experimental and mathematical research which would establish rational science in the place now occupied by the empirical methods and which might expand the fields of development in the speaker's branch.

The speakers give frequent opportunity for the students to ask questions. The students are urged to interrupt the speaker freely with questions at any time, and to enter into the discussion of the conclusions. The effect of the Colloquia upon the students has been to awaken them to a more sincere appreciation of the importance of a thorough grounding in fundamental principles as a preparation for real engineering work, and to a realization of the wealth of fascinating problems yet to be solved. The effect upon the staff has been to produce considerable fertilization of instruction.

A somewhat similar influence as derived from the Colloquia is obtained from certain semester subjects given by experts invited from the industry.*

Further understanding of the conditions of engineering work and a certain degree of inspiration are gained from a series of lectures given by prominent and successful men in various branches of the engineering profession, and known as the Aldred Lectures † after their founder, Mr. John E. Aldred. All senior year and graduate students at the Institute are invited to these lectures.

In 1928–1929 a Chair of Humanics is to be established. The aim is to emphasize character in the students and try to stimulate through talks and round-table discussions their common sense and a sense of relations. It is proposed to use as illustra-

* See the Institute Bulletin on the Department of Electrical Engineering, 1928 issue, p. 25.

† *Ibid.*, p. 13.

tions successful and unsuccessful men, with emphasis or criticisms of the traits of each type, and current business events which have a bearing on human relationships.* The whole thing is as yet in the embryo stage. It is probable that the subject will be optional, limited to students of the junior and senior years. Plenty of opportunity will be given for personal conference with the professor in charge. It is expected that the establishment of the Chair of Humanics will accomplish substantially the same purpose for all students at the Institute that the junior year lectures of the Department of Electrical Engineering serve for students in the courses in Electrical Engineering.

In the senior year, the electrical engineering curricula include a special subject of English which consists of the study of the lives of great scientists, engineers, financiers and statesmen with oral and written reports and discussions thereon. The subject matter furnishes background for the scientific and technical studies, and the practice in organization and presentation of material is valuable training for those who will have to report on engineering projects to superiors.

Other liberalizing influences at the Institute are the General Studies † and the Whiting Concerts, a series of musical expositions given at a number of eastern institutions. The rest of the liberalizing is left to the influence of Bostonian surroundings, the advantages of which are many.

In summary and in conclusion it is pointed out that the courses in Electrical Engineering are founded on a strong mathematical-physics basis upon which the processes of instruction, orientation and liberalization are built and correlated. This fundamental ground work in the theoretical aspects of Electrical Engineering is supported by much laboratory instruction and investigation relating to the principles of electricity and magnetism and their useful applications. In addition the courses include instruction in mechanics, thermo-

* Dr. Gow, a prominent engineer of Boston who has been selected for the Chair of Humanics, states that he will attempt "to define the indefinable, explain the unexplainable, and unscru the unscrutible."

† See the Institute Bulletin, Catalogue Issue, April 1928, pp. 261–267.

dynamics, hydraulics and their applications, buttressed by studies in economics, English and history. This paper deals with the pedagogical principles and methods in use in the Department and does not cover the content of the subject matter as taught. The various topics treated in this paper are collateral to, and an aid in, the accomplishment by each student of hard, substantial and successful work while under instruction, and they help to prepare him for the proper independent exercise of his duties in the engineering world after graduation.

DIGEST OF PAPERS PRESENTED BEFORE ELECTRICAL SESSION AT CHAPEL HILL CONVENTION OF THE SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION, JUNE 27, 1928

READING FOR HONORS

BY LEWIS FUSSELL

Professor of Electrical Engineering, Swarthmore College

The educational method, "Reading for Honors," was started at Swarthmore College in 1922 by President Frank Aydelotte. Inspired by the system long in use at Oxford, it has been largely modified to fit our national and local conditions. To clarify this calls for some picture of our local situation.

Restricted enrollment, manifold applications, yield highest grade of students. Well endowed and with excellent laboratory facilities, there is a long established leaning of men students toward the scientific rather than literary or so-called cultural subjects.

The idea behind Honors is, of course, that the unusually brilliant and capable student be relieved of the necessity to keep step with his slower fellows and have an opportunity to advance as far and as fast as his individual powers make possible.

At the end of the sophomore year those who desire, make

application for permission to read for honors. Rarely do those apply who should not; on occasion a good man needs to be encouraged to apply.

During the junior and senior years in divisions other than engineering, students who are reading for honors meet in groups of not more than five for one afternoon each week, with two or three instructors. Discussions of readings assigned for the week are very free and frank. Attendance at certain lectures is advised and a certain number of papers must be presented. No examinations are held until the close of the senior year, when written and oral examinations of great searching power are given by men *not of the college faculty*. This use of outside examiners gives a large degree of intellectual freedom to the instruction and we have been very fortunate indeed in securing men of sympathetic interest. The examiners rate candidates as being worthy of Highest Honors, High Honors, Honors, recommend that they be graduated without honors, or that they are unworthy of graduation; the latter being rare and subject to faculty review. Candidates who during the course of their junior and senior years fail to avail themselves of their opportunities, or who loaf on the job, are unhesitatingly reduced to the ranks, although comparatively few such cases have been necessary.

The above mentioned system applies in most details to Honors in the Division of Engineering, although certain rather fundamental modifications have been found advantageous. Due to the natural sequence of courses, the greater dependence on a thorough knowledge of fundamentals than is the case in literary work, a larger amount of class room work is advised for engineers than for English, Social Science or Language students. For instance, hydraulics for an electrical engineering honors man, or electrical engineering theory for a civil, would be covered by attendance in the same classes with non-honors men, whereas, hydraulics for a civil engineering honors man would be handled much more thoroughly, more deeply and according to honors methods.

In electrical engineering the first two weeks are taken up with a thorough and searching grill over basic physical rela-

tions. Such ideas as matter, energy, force and work, current, charge, potential, power, are run to earth and clarified to a degree they had never been before.

The work has been outlined in very considerable detail, the number of weeks allotted to each phase being, however, subject to revision in the light of each individual's leaning. For instance, a man who knows he is headed for telephone work has a greater time in speech transmission and less on synchronous machinery.

Once the number of weeks per subject is assigned, the candidate is given a list of readings by page and book or periodical, a group of laboratory experiments to conduct and is encouraged to extend these assignments just as far as he can in the period allotted.

The system works for independence of thought, for self-reliance, for appreciation of the value of time, since each candidate budgets his own life on a large rather than a closely supervised scale. We are told by our examiners that our successful candidates rank not so high as a Master, but distinctly better than the product of a regular four-year course.

The weekly conferences are a very real joy, a degree of interest, a freedom of discussion, a depth of thought being revealed which exceed those of any other teaching method I personally have encountered in a quarter century of teaching.

SOME ASPECTS OF THE ELECTRICAL ENGINEERING TEACHING PROBLEM

BY CHESTER L. DAWES

The Harvard Engineering School

During the past twelve or fifteen years electrical engineering has undergone such a rapid and diversified development that the practising electrical engineer becomes bewildered in attempting to keep in touch with the entire field. Refinement of design has now become a very pressing problem in the industry. This has led to the development of research on a large scale by

the large industries and has necessitated the employment of technical experts by the smaller industries. Applications of electrical engineering require intimate knowledge of such subjects as heat flow, mechanics, electron theory, laws of ionization and mathematics. That is, the electrical engineer is also expected to be a mechanical engineer, physicist and mathematician. Many electrical engineering developments depend on fundamental laws of physics such as thermionic emission which occurs in electron tubes and ionization which occurs in high-voltage insulation. The determination of many of these fundamental laws comes well within the realm of physics, but the need for fundamental laws in the applications of electrical engineering has made it necessary for electrical engineers to perform much fundamental research themselves. The artificial dividing line between electrical engineering and physics is rapidly disappearing. Electrical engineers have also advanced mathematics in certain directions in order to solve their own special problems.

Because of the wide scope of electrical engineering and the detailed knowledge now required of each special field, the electrical engineer in order to become a recognized expert must concentrate in one particular field, but must also have a general knowledge of allied subjects. It has become practically impossible for an electrical engineer to be a recognized expert in several different fields of electrical engineering. The foregoing conditions in the electrical industry are placing a premium on students of analytical ability who have shown aptitude in mathematics and physics, and make it difficult to retain such students for instructors and for graduate work.

Widened scientific knowledge and the demands of industry have increased the number of fundamentals which it is now necessary to teach. For example, vacuum tubes are used to some extent in most all branches of electrical engineering and a knowledge of their principles is essential to electrical engineering training. Laboratory work is an important part of electrical engineering instruction. It should be given in such a manner that the student should be thrown to a large extent

on his own resources, even if his actual experimental data suffer at first.

The Harvard Engineering School has attempted to meet the foregoing demands for well-trained engineers by offering a simplified and unified curriculum containing a good proportion of general studies, basic sciences, the fundamentals of allied engineering subjects, rounded out with a few comprehensive but fundamental courses in electrical engineering. The total number of subjects is small. Specialized electrical-engineering subjects such as Dynamo Design and Electric Railways are given for the most part as graduate rather than as undergraduate courses. Students in good standing, however, are sometimes permitted to take these courses with the consent of the professor in charge.

SOME FACTORS IN THE TRAINING OF ELECTRICAL ENGINEERS

BY LEONARD P. DICKINSON

University of Vermont

The transition from the atmosphere of the conventional student life to the activities of a business or a professional career, necessitates a period of readjustment to the young engineer which is usually especially difficult. In this period the whole of his future career may be made or marred since his success in meeting the new problems which come to him is to his employer a measure of his ability, and to the man himself a test of his fitness for his chosen profession.

The curricula of modern technical institutions have been planned with a view to minimizing the difficulties of this period, in so far as technical problems are concerned.

Modern engineering practice demands of a man something more than a mere proficiency in technical matters. His personal qualities determine his success or failure quite as much as his mental equipment. This being true, it is obvious that the development of these personal qualities should be a definite part of the training offered. Many institutions recognize this

fact, and some have adopted rather elaborate personnel systems, wherein each student is rated upon the various qualities which pertain to his personal equation, and in which conferences are held at stated intervals with a view to the elimination of objectionable personal characteristics, and the development of those which seem desirable. The question is raised as to whether it is enough merely to direct a student's attention to his needs in the direction indicated. It is suggested that a system of grading be adopted with regard to personal qualities, just as is universally done with regard to scholarship. It would also seem that possibly a student should be required to attain a definite grade in personality as well as in scholarship, as a prerequisite to the attainment of a degree.

It is even possible that students deficient in academic standing including their personal qualities, should be eliminated at the proper point in their course, possibly at the end of their second year.

Prominent among the qualities for which employers seek are promptness in the meeting of professional obligations and regularity in the performance of the daily task. It is questionable whether the atmosphere of the average college tends to develop the qualities mentioned. Aside from an attendance upon stated exercises in the class-room and laboratory, the student's time is largely his own. To some, this may seem desirable, since in holding him responsible for results and in leaving him free to attain these results as may seem best, we theoretically develop in the student a sense of personal responsibility. Practically, however, this system is responsible for a large number of failures, especially in the earlier years of the course. Human nature is such that definite accountability for the regular performance of a daily schedule is necessary in the case of the vast majority of people especially in the early and formative period of their careers. This fact is recognized in industry—to ignore it would result in chaos in the modern business house or manufacturing plant.

It would seem therefore that in the training of young engineers this element of accountability for time should be more strongly emphasized. The college should assume something

of employment as a student and his progress toward more responsible work should depend upon the daily performance of the role of an employer toward the student. His tenure of stated duties at definite times. The class-room and laboratory should duplicate to a considerable extent the atmosphere of the office, the drafting room and the testing floor.

THE SPECIALIZED TECHNICAL SUBJECTS OF THE ELECTRICAL ENGINEERING CURRICULUM

BY A. S. HILL

Professor of Electrical Engineering, University of Maine

Specialized technical subjects are not only important as a means of familiarizing the student with the different branches of his profession, but are also especially valuable in the role of media for presenting fundamental principles in their proper setting and affording drill in their use. As instruments of general education in the work of the senior year these specific courses possess the following outstanding advantages over a mere non-specialized continuation of the introductory work on principles of electrical engineering:

1. An advanced course in some definite branch of engineering activity stimulates the student's interest and enlists his cooperation to a degree that is difficult to duplicate in the broader study. The professional character of the work and the immediate application of theory to comprehensive problems that the student deems worthy of his serious attention, serve apparently as powerful incentives to achievement. In fact, the driving force of the average student's laudable ambition to excel in some specific line of technical work which at the time appeals to him as particularly attractive, is one of the instructor's strongest allies in the task of extending the young man's interests beyond the boundaries of technical accomplishment into the broader phases of engineering responsibility.

2. The comprehensive and realistic problem material of a specific technical course results in a more adequate training

in the application of principles to practical affairs. In the case of the engineering student fundamental training implies much more than a mere familiarity with principles. It calls for an extended drill in the use of these principles under conditions similar to those of actual work. The problems of a general course, interesting and useful though they may be, are as a rule too limited in scope to serve this end. They show the student how to deal with individual situations when presented successively in logical and predetermined order, something quite different from the maze of interacting phenomena and conflicting requirements that so often confront the engineer in his work. Senior students should be required to extend their thinking beyond the one-principle type of problem and learn how to use theory in connection with a complete design, an exhaustive analysis, or an entire sequence of operations. Only in this way can they acquire that grasp of principles in action that will enable them successfully to attack the complex problems of actual practice and see them through to a finish.

3. The practical application of economic principles, which in the future must be given greater weight in the analysis and problems of engineering courses, can be taught to better advantage in connection with specialized technical subjects. The deeper penetration of these subjects into the details of design, application, and operation, and the more elaborate projects and investigations for which they provide adequate background, offer exceptional opportunities for familiarizing the student with the economic phases of engineering activity and impressing on his mind the importance of financial, legal, and social responsibilities in the higher positions which he hopes some day to attain.

4. Intensive study in a restricted field affords superior mental discipline. In the majority of general subjects the time devoted to a given topic and the pertinent experience which the student brings to its study are insufficient to permit him to be much more than an observer of the analytical methods outlined in the textbook or employed by the instructor. In these studies, lines of thought are seldom carried far enough

or sufficiently interconnected to contribute very effectively to the development of independent, sustained, and thorough thinking powers. Detailed study in a relatively narrow and highly realistic field soon qualifies the student to undertake larger projects, in which the attempt to connect basic principles on the one hand with quantitative results acceptable in practice on the other, requires him to exert his native intellectual gifts under conditions requisite for their greatest development.

Specialized technical subjects can be rendered still more effective by the adoption of methods of instruction which simulate as far as possible the atmosphere of the engineering office, the engineering society meeting, or the conferences of the junior engineer with his supervising superiors. These conditions can be respectively approximated in the methods of the computing room, the seminar, and the tutorial system, methods which have the added advantage of permitting the gifted student to undertake more difficult problems or a wider range of study without interfering with or being hampered by the less able members of the class.

ELECTRICAL ENGINEERING INSTRUCTION IN THE DYNAMO LABORATORY

BY DUGALD C. JACKSON, JR.

University of Louisville

There are several results to be achieved by laboratory instruction in electrical engineering—a knowledge of the operating characteristics of the machines and the acquisition of laboratory technique or, viewing it in a broader light, the thorough understanding of the investigative method.

Preliminary preparation for laboratory experiments is of the utmost importance. The best method of insuring this preparation is to require from the students a preliminary report submitted several days before the laboratory period. It may be written at home or in a 2- or 3-hour period under supervision, but the instructor should read it and discuss it

with the student before the experiment is performed. A final report covering the calculations of results, curves and conclusions is written after performing the experiment. This two-report method insures that the students prepare themselves for the laboratory work, whereas the indefinite assignment of merely being prepared to perform the experiment is difficult to enforce. The detailed step-by-step instructions required when *not* using the preliminary report method are enervating to the student's mind; he becomes a mere automaton following the suggestions in his printed instructions. The preliminary report method energizes the student's mind since it challenges his ability to plan his course of action.

In the organization of the laboratory, maximum flexibility and opportunity for improvisation by the student should be provided. The arrangement of the machines should be such as to make it easy to gain as complete a knowledge of the construction of the machines as possible, and it should facilitate the performance of the experiments and thus obtain maximum results in the time allotted. Commercial types and sizes of machines should be used as far as possible. Their capacities should be much the same in order to cut down the diversity in size of meters and instruments required. To afford the greatest flexibility of machines and their movement and change in use, terminal jacks should be mounted directly on the machine itself. To prevent the laboratory instruction from becoming static and to insure its keeping pace with the progress of the profession, the organization of the laboratory and the arrangement of the machines must not be permitted to become frozen. In any engineering laboratory there is a large investment which for economic reasons alone should be used to the maximum with the minimum of idleness. The flexibility achieved by having the apparatus movable and not permanently connected to a fixed panel comes nearest to this ideal.

The student should make the most of his time in the laboratory and should get a complete understanding of the experiment and the results he is to obtain. The accuracy of the results, especially in the early laboratory work, is of less

importance than the development of the student's ability to think logically, to finish the job in the time allowed, to overcome difficulties for himself, and especially to obtain an understanding of the investigative method. To effect this, the laboratory parties should be small—never more than four students, preferably two or three.

One aspect of laboratory instruction, sometimes overlooked, is the opportunity to form judgment of the student's ability to make practical application of his theoretical knowledge. This grading should be done while the student is in the laboratory—not later. Unless stress is laid on the mark for the work actually done in the laboratory, laboratory grades tend to become grades on written reports only, the data having been taken by the student in the laboratory. The laboratory quiz when not used too often is very effective in obtaining a good judgment of the student's laboratory ability and also of affording him the training of having to think clearly and rapidly while working under stress in a radically different method from that of problem sections or examinations.

A close correlation between the class-room instruction and laboratory exercises is a distinct advantage during the early part of the electrical engineering course. In the latter part of the junior year and the senior year, it is better to make no effort to correlate, provided the general groundwork of the experiments is covered before they are performed. This encourages personal study and original effort and aids materially in instilling in the students the principles of the investigative method.

Laboratory instruction, on the one extreme, is given by all members of the faculty every year. On the other extreme the instruction is under the supervision of an experienced man but the actual work is done by young instructors with little teaching experience. The young instructor brings abundant energy and enthusiasm to his job merely because it is his first job. He can be expected to run each experiment personally the first year as an instructor which makes him of value to the students in a way that cannot be equalled by a man who has not performed the experiments recently.

The interests in educational work of the older men of the faculty are usually not along that line of laboratory instruction. These men often find it a drag to teach laboratory classes, and as a result are not as effective as the young instructor who is enthusiastic about all of his work. The greatest inspiration to the student comes from the more experienced men on the faculty, and there is a better chance to transmit this inspiration in the class-room than in the laboratory. Thus it is to the best interests of an engineering school to have the laboratory work given by young instructors, under the supervision of an experienced man, and to keep the class-room as far as possible in the hands of the older members of the faculty.

THE TEACHING OF ELECTRICAL DESIGN

BY A. C. LANIER

University of Missouri

The teaching of electrical design and the place of such instruction in the electrical engineering curriculum, should be considered not from the point of view of training prospective designing engineers only or even largely, but from the point of view of the value of such instruction to all students of electrical engineering. It so happens that the theoretical background for electrical design, the theory of electromagnetic machinery, and much of the necessary analytical technique are of equal usefulness in other functional divisions of electrical engineering.

In the writer's opinion the place to begin the study of electrical design is in connection with the theoretical study of electromagnetic machine theory. Carefully selected design problems and laboratory experiments closely correlated with one another and with the theoretical study are an effective means of amplifying and driving home the theory. Care must be exercised, however, both in the selection and in the correlation of these studies. Design problems can be used to better effect than experimental studies in connection with certain

phases of machine theory. With other phases, the experimental method is more illuminating. The two methods are, with many types of problems, complementary, each bringing out important theoretical considerations, not emphasized adequately in the other.

The inclusion of design problems and experimental studies as integral parts of advanced courses in electrical machine theory would entail some administrative changes, but no major administrative difficulties. It calls for a somewhat closer degree of cooperation on the part of the departmental staff, than required for separate design problem, laboratory and theoretical courses covering the same ground. This closer collaboration, however, should, in itself, react favorably upon the quality of the instruction.

If rightly planned, the design problems, which are correlated with the theoretical study of electrical machinery, will serve as an adequate introductory course in electrical design. Whether such introduction should conclude the instruction in this field or should be followed by a more comprehensive course in electrical design, will be governed, in no small measure, by the professional experience and interests of the particular staff concerned. With these conditions favorable, further instruction in this field is desirable, in the writer's opinion, both on account of the more thorough-going quantitative grasp of electromagnetic relationships which such instruction would tend to assure and on account of its value in stimulating certain desirable mental traits and habits.

In planning a general course in electrical design, several promising alternatives, both as to general character and emphasis, present themselves. One kind of course calls for the design of several representative types of electrical machines, such as an alternating current transformer, an induction motor, a synchronous alternator or motor and a continuous current generator or motor. It would involve the calculation of preliminary over all dimensions, detail dimensions and arrangement of magnetic structure and windings, and the determination of performance characteristics.

Another alternative, not electrical design strictly perhaps,

is a problem course in typical industrial applications of electrical apparatus. Here the demands of the particular application would first be analyzed, and the type and size of the complete electric equipment, suiting best the conditions of the problem would be selected. Still another choice is an extended and intensive study of important special problems in the field of electric design. Such studies would generally be at least semi-investigational in character, and are especially adaptable to the needs of graduate or advanced students.

Here again the interests and professional contacts of the staff would largely govern the type of course selected. The writer's preference is for a general course in the design of electrical machines followed, for selected advanced students, by a further study of special design problems.

A well ordered course in electrical machine design, the first of the three alternate types of course mentioned above, will establish a rational basis for calculating the overall dimensions of electromagnetic machinery, and will emphasize the character and quantitative significance, in such calculations, of the fundamental design constants. It will point out those detail dimensions which have especial significance, as well as the considerations which govern the determination of such dimensions. The influence of both the design constants and significant detail dimensions upon the characteristic performance of the machines will be made apparent, as well as the effect upon performance of changes, often slight, in significant detail dimensions. Moreover, through comparison, the identity of the fundamental electromagnetic relations in the several types of machines will be manifest, and the causes for their wide differences in functioning properly accounted for.

In addition, the student should acquire, through use, a firmer grasp of analytical method. He should come to some appreciation of the dependence which the engineer can place upon analysis and where analysis should be backed by investigation and experience. Finally, it will give the student an opportunity even though slight, for the exercise of judgment, and will point to the sorts and sources of information upon which engineering judgments are based. These disciplinary

gains are perhaps not the least important points in the case for the teaching of electrical design.

WRITTEN DISCUSSION SUBMITTED BY W. I. SLICHTER, PROFESSOR OF ELECTRICAL ENGINEERING, COLUMBIA UNIVERSITY

The Department of Electrical Engineering of Columbia University has included a course on the design of electrical machinery in its curriculum for more than twenty-five years and still continues to do so.

The main object of our course, however, is not to make designing engineers of our students but to give a good training in practical applied problems in the electric circuit, the magnetic circuit, the dielectric circuit, in applied mechanics and finally to inculcate a thorough understanding of the internal workings of electrical machinery. No student really understands the electromagnetic reactions in an electric machine until he has made a complete quantitative analysis of a specific machine. Laboratory tests give only a superficial acquaintance.

Our course extends for an entire academic year with two lectures in one afternoon computing period per week. The first term is devoted to D.C. machines, shunt, compound and series, and the second term to A.C. machines, alternator, transformer and induction motor.

I have found it more practicable and more interesting to the students to assign them computations of a machine which actually exists and I stress the individuality and personality of the machine by assigning one which we have in our laboratories or one which is the outstanding subject of some article in a technical magazine such as the article on one of the Queenston generators in the *A. I. E. E. Journal* of June 1922.

If one of our own machines is assigned as a problem I have it opened up and give the student an opportunity of collecting such dimensions and characteristics as he can and then ask

him to design a machine as near like this one as he can. A card file of the physical dimensions of all the machines in our laboratories and of their characteristics is one of the features of our course .

In the case of unusual machines, such that a school laboratory would not possess, *i.e.*, large turbo-generators, I refer the student to a description of such a machine in a technical magazine or in the advertizing publications of the manufacturing companies. In these there is usually enough specific data to give the student, with the aid of the instructor, a good start, and enough of the characteristics to make an interesting comparison with the final results of our computations. I derive an extra interest for myself by reassigning the same machine a second or third year, each time making closer approximations myself and giving the student the benefit until we can make our predicted characteristics check exactly with those claimed by the manufacturer.

It will be found that by watching the technical press a card file can be compiled giving references to a large number of interesting pieces of apparatus of a wide variety of types and makes. I have two or three hundred myself.

It is our experience that the student does better work and displays more interest if the example he is working upon is a definite machine having a real existence rather than being merely the result of his own guesses and estimates and, of course, he realizes that the proportions he finds are those that have met the test of practical commercial application.

We do not require elaborate drawings as is the custom in Europe, but only such sketches, to scale, as are necessary to show the dimensions of the magnetic circuits and the cross-section of a coil or slot. We try to require only those drawings as would be made by the Designing Engineer himself and not those made by the draftsman. This saves much time and enables us to consider a greater variety of examples.

It has been found, after long experience, that the student experiences a feeling of great satisfaction on the completion of the computations in finding that the result of the combination of these various calculations gives the complete character-

istics of a definite machine which he may compare with the test results obtained in our laboratories or published by the manufacturer.

For many years the course was required of students in electrical engineering but since our curriculum has been extended so as to require an extra year for the E.E. degree, after the B.S. in Engineering, this course has been placed in the last year, after the attainment of the B. S. Here there is more opportunity for specialization and some of the men looking forward to "Communication" work specialize along that line, but the majority elect the "Power" option and all these take our design course.

COMMENTS UPON THE DISCUSSION OF PROFESSOR W. I. SLICHTER BY A. C. LANIER

The writer is pleased to find himself in substantial agreement with Professor W. I. Slichter as to the purposes, content and method of treatment of courses in electrical machine design. The slight differences in method suggested in Professor Slichter's discussion appear to arise, in part at least, from differences in content and treatment of courses prerequisite to that in electrical design, that is, the advanced courses in electrical machine theory.

As mentioned in his paper, the writer correlates design and laboratory problems with the advanced course in electrical machinery. The design problems relate, in most cases, to laboratory machines, and most of the problems may be and are verified experimentally. The advantages of having the student check experimentally the characteristics of machines determined by calculation from machine dimensions are well stated by Professor Slichter.

The writer's course in electrical design proper, for which the advanced course in electrical machine theory is prequisite, is required of applicants for the advanced degree in electrical engineering and will, in future, be elective for seniors. In this course the complete dimensions of the magnetic structure, the windings and the operating characteris-

tics of several different types of machines are calculated. Considerable emphasis is placed upon the rational determination of the overall dimensions of machines, the fundamental design constants which enter into such calculations and the factors which influence the choice of the constants. To the writer, it has seemed worth while to allow the student, particularly in view of his preparatory training through the use of design problems, to make his own choice of the fundamental design constants, provided information relative to constants used in similar commercial machines is placed in his hands as a guiding suggestion.

The inevitable adjustments in these assumed constants in order to secure desirable windings and detail dimensions and the further changes frequently required to meet specified performance effectively emphasize the several factors which influence the choice of design constants. Furthermore, the influence of design constants and significant machine dimensions upon operating characteristics of machines, as well as the important changes which may be effected in the latter through changes in one or both of the former, will be impressed upon the student in a quantitatively convincing manner which the mere analytical study of electromagnetic machine theory utterly lacks.

MASS, WEIGHT AND FORCE

BY WM. L. DE BAUFRE

Technical Adviser, International Combustion Engineering Corporation

In an article on "The Pound as Compared with the 'Slug' as a Unit of Mass," which appeared in THE JOURNAL OF ENGINEERING EDUCATION for April, 1928, the author in conclusion entered a plea for the adoption of the pound instead of the slug as the unit of mass. This plea is endorsed for the reason given by Professor Hickerson, namely that the slug "is not met with in everyday life and hence its use in mechanics tends to confuse and mystify the student."

At the bottom of page 839, however, Professor Hickerson follows the custom of textbook writers on physics in indicating a difference between the results of weighing on a balance scale and on a spring scale. From this misconception follows the error of indicating the local value of gravity g in the formulas tabulated on page 840. In all these relations except one, the standard acceleration of gravity g_o only is correct by reason of the legalized commercial practice of calibrating all kinds of scales with "standard weights." It is the object of the present article to discuss this matter at some length.

When the metric system was instituted by the French republic in 1801, the unit mass of one gram was defined as that of a cubic centimeter of water at the temperature of maximum density, 4 degrees centigrade. A platinum-iridium cylinder was made to represent a mass of one kilogram. But as the original measurements were later found to be slightly inaccurate, the kilogram unit of mass is now defined as the mass of this platinum-iridium cylinder, which is called the "standard kilogram" and is preserved at the International Bureau of Weights and Measures near Paris. In the United States the "standard pound" is legally defined in terms of the international kilogram by the relation

$$\text{One pound} = 1/2.204622 \text{ kilogram}$$

Hence, in this country all units of mass, in the English as well as in the metric system, are based on the "standard kilogram" preserved near Paris.

The United States Bureau of Standards possesses prototypes of the "standard kilogram." "Standard weights" are compared with these prototypes by "weighing" on an equal arm balance and correcting for the buoyancy of the atmosphere. These "standard weights" are used to check other "standard weights" which are sent out over the country for the calibration and adjustment of scales of all kinds. There is no difference in the weight of a body as determined on a "spring scale" or on a "balance scale," for it is customary to calibrate each scale in the place where the weighing is done, by means of "standard weights" directly or indirectly checked with "standard weights" at the U. S. Bureau of Standards in Washington. Irrespective of the latitude of the locality in which the weighing is done and whether it be at sea level or on top of a mountain, the weight of a given mass will always be the same number of pounds or of kilograms because the scales on which the weighing is done are adjusted according to such "standard weights." Allowance should be made, of course, for the buoyancy of the atmosphere. The mass of a body is thus the same as its weight measured in pounds or in kilograms.

Force is a push or a pull exerted by one body upon another; and the second body always reacts upon the first one with an equal but opposite force, that is, action and reaction are equal. To measure a force, we always use some kind of a weighing machine between the two bodies between which the force action takes place. Thus, in brakes for measuring the power output of engines, we insert a spring scale or a balance scale between the brake arm and the earth. In measuring the tractive effort of a locomotive, we insert a spring scale between the locomotive and the remainder of the train. These scales are calibrated and adjusted by means of "standard weights" in the locality in which they are used and are graduated in the corresponding numbers of pounds or of kilograms.

Hence all measured forces are expressed in terms of the pull of the earth on "standard weights."

Unfortunately, the pull of the earth does vary with latitude and with elevation and is not always the same at two places having the same latitude and elevation. Hence some standard locality must be selected in defining accurately the unit of force. The kilogram force is the pull of the earth upon a kilogram mass in the locality of standard gravity. The pound force is 1/2.204622 kilogram force. The corrections to be applied when forces are measured on scales adjusted by standard weights elsewhere than at the locality of standard gravity have been found by experiment, but as these corrections are generally expressed in terms of the acceleration of gravity rather than the force of gravity, the relation between force and acceleration will now be discussed.

When an unbalanced force acts upon a mass, it will produce an acceleration the magnitude of which will be directly proportional to that of the unbalanced force acting. When a body falls freely to the earth, it will have the acceleration of gravity which will vary from one locality to another in proportion to the variation in the pull of the earth, or force of gravity, upon the body. Let the acceleration of gravity be denoted by g_0 in the location of standard gravity and by g in some other locality; let the force of gravity be denoted by w_0 in the location of standard gravity and by w where the acceleration is g. Then $w/g = w_0/g_0$, or $w = w_0\ (g/g_0)$. Thus, if a scale be calibrated with "standard weights" in a locality where the local acceleration of gravity is g, then the true values of the *forces* measured will equal the scale readings multiplied by the local acceleration of gravity divided by the standard acceleration of gravity.

In designing machines and in analyzing the performance of machinery, it is necessary to deal with forces other than the force of gravity as related to the motions of the various masses involved. These masses are determined by weighing on scales calibrated with standard weights. A given mass will weigh w_0 lb. If this mass were in the locality of standard gravity,

the pull of the earth upon it would be w_0 lb. and this force would produce the standard acceleration of gravity g_0 ft. per sec. per sec. If another force of F lb. acts upon this mass of w_0 lb., it will produce an acceleration of a ft. per sec. per sec. such that $F/a = w_0/g_0$ or $F = (w_0/g_0)\ a$.

It is particularly to be noted that the acceleration of gravity in this relation is standard gravity, universally adopted as 980.655 cm. per sec. per sec. or 32.1740 ft. per sec. per sec., and not the local acceleration of gravity. This standard value may be abbreviated to 32.17 or 32.2 or even to 32, but it is standard gravity which is to be used in general in formulas and relations of mechanics because scales are calibrated by means of standard weights. The local value of gravity should be used only to correct the readings when measuring forces by means of spring or balance scales.

All force measuring devices, except a few scientific instruments, are graduated in grams or in pounds. The dyne is a theoretical unit of force that may be defined as the unbalanced force which will give to a mass of one gram an acceleration of one centimeter per second per second. Since an unbalanced force produces an acceleration which is directly proportional to the unbalanced force and inversely proportional to the mass acted upon, the above definition will enable us to write

$$F = Ma$$

where F = the unbalanced force in dynes,
M = the mass (weight) in grams, and
a = the acceleration in cm. per sec. per sec.

The statement "force equals mass times acceleration" is thus correct when we express the force in dynes and the mass is the weight in grams. When we measure the force in pounds or in grams, however, this statement is not correct, but we must use the relation "force divided by acceleration equals weight (pull of earth at standard gravity) divided by standard acceleration of gravity." Weight has therefore two meanings—either the mass when we are buying or selling materials or

making calculations involving forces in dynes, or the pull of the earth at standard gravity when we are making calculations involving forces in pounds or in grams. Weight is only approximately equal to the local pull of the earth upon a body.

The units of "poundal" for force and of "slug" for mass were undoubtedly invented in order to apply the relation "force equals mass times acceleration" to the English system of units. If these units are to be avoided with students because they have never come into practical use, then it would appear that the expression "force equals mass times acceleration" should not be employed with English units.

The following table gives a number of common relations between mass, weight and force for the three systems of units most often employed. The centimeter-gram-second, or c.g.s., system, is universally employed in scientific work. In this system the acceleration of gravity appears only once, namely, in the expression $M\ gh$. for the potential energy in ergs of a mass of M gm. raised to a height of h cm. The local value of gravity should evidently be used in this expression because we are concerned with the local pull of the earth upon the mass of M gm. The other two systems indicated are commonly employed in engineering and commercial work. Only the standard acceleration of gravity g_0 appears in the various relations tabulated, except in the one for the potential energy of a mass of w *lb.* (kg.) raised to a height of h ft. (m.), since in this case we are concerned with the local pull of the earth exerted upon a weight of w. lb. (kg.). The "weight" w lb. (kg.), which is the pull of the earth at standard gravity, must be multiplied by the ratio of the local to standard gravity in order to get the local pull of the earth.

It will be noted that in every case where the scientific (c.g.s.) system employs the mass M, the practical systems use the weight w divided by standard gravity g_0. Hence it becomes easy to convert the expressions from one system to the other by substituting w/g_0 for M. When forces are measured in pounds or in kilograms, we can thus by anology say that the mass is equivalent to the weight in pounds divided by 32.1740

	cm.–gm.(mass)–sec.	m.–kg.(force)–sec.	ft.–lb.(force)–sec.
Mass or weight	M gm.	w kg.	w lb.
Acceleration	a cm./sec./sec.	a m./sec./sec.	a ft./sec./sec.
Force	$F = Ma$ dynes	$F = (w/g_0)a$ kg.	$F = (w/g_0)a$ lb.
Radius of gyration	r cm.	r m.	r ft.
Moment of inertia	$I = \int x^2 dM$ $= Mr^2$ gm.-cm.	$I = \int x^2 dw$ $= (w/g_0)r^2$	$I = \int x^2 dw$ $= (w/g_0)r^2$
Angular acceleration	α rad./sec./sec.	α rad./sec./sec.	α rad./sec./sec.
Torque	$T = I\alpha$ $= Mr^2\alpha$ dyne-cm.	$T = I\alpha$ $= (w/g_0)r^2\alpha$ kg.-m.	$T = I\alpha$ $= (w/g_0)r^2\alpha$ lb.-ft.
Linear velocity	v cm./sec.	v m./sec.	v ft./sec.
Linear momentum	Mv	$(w/g_0)v$	$(w/g_0)v$
Angular velocity	ω rad./sec.	ω rad./sec.	ω rad./sec.
Angular momentum	$I\omega = Mr^2\omega$	$I\omega = (w/g_0)r^2\omega$	$I\omega = (w/g_0)r^2\omega$
Vertical height	h cm.	h m.	h ft.
Potential energy	Mgh ergs	$(w/g_0)gh$ m.-kg.	$(w/g_0)gh$ ft.-lb.
Kinetic energy of translation	$\frac{1}{2}Mv^2$ ergs	$\frac{1}{2}(w/g_0)v^2$ m.-kg.	$\frac{1}{2}(w/g_0)v^2$ ft.-lb.
Kinetic energy of rotation	$\frac{1}{2}I\omega^2 = \frac{1}{2}Mr^2\omega^2$ ergs	$\frac{1}{2}I\omega^2 = \frac{1}{2}(w/g_0)r^2\omega^2$ m.-kg.	$\frac{1}{2}I\omega^2 = \frac{1}{2}(w/g_0)r^2\omega^2$ ft.-lb.

ft. per sec. per sec., or to the weight in kilograms divided by 9.80665 meters per sec. per sec. It is not necessary to refer to this ratio as a new quantity measured in slugs.

In addition to eliminating the "poundal" and the "slug" from textbooks on mechanics because these units have never come into general use, we should go one step further and make the definitions and relations conform to common practice in the measurement of mass, weight and force.

NEW MEMBERS

ALFORD, LEON P., Vice President, The Ronald Press Company, 9 North Mountain Avenue, Montclaim, N. J. J. W. Hallock, E. A. Holbrook.

ALLEN, CHARLES L., Assistant Professor of Mechanical Engineering, Pennsylvania State College, State College, Pa. R. L. Sackett, H. A. Everitt.

AMANDUS, LEO, BROTHER, Instructor in Civil Engineering, Manhattan College, New York City. John F. Furia, H. P. Hammond.

ANDERSON, EDWARD, Assistant Professor of Mechanical Engineering, University of Nebraska, Lincoln, Nebr. O. J. Ferguson, J. W. Haney.

A. MICHAEL, BROTHER, Dean of Engineering, Manhattan College, New York City. John F. Furia, H. P. Hammond.

BOWERSOX, ERWIN R., Associate Professor of Mathematics, State School of Mines, Butte, Mont. F. L. Bishop, Nell McKenry.

BOOTH, JAMES L., Instructor in Mechanics, University of Nebraska, Lincoln, Nebr. O. J. Ferguson, J. W. Haney.

BUNTING, ALBERT E., Assistant Professor of Mechanical Engineering, University of Nebraska, Lincoln Nebr. O. J. Ferguson, J. W. Haney.

CANAVACIOL, FRANK E., Assistant Professor of Electrical Engineering, Polytechnic Institute of Brooklyn, Brooklyn, N. Y. E. J. Streubel, H. P. Hammond.

DUNSTAN, GILBERT H., Instructor in Drawing and Machine Design, Tulane University, New Orleans, La. C. W. Ricker, J .M. Robert.

FARRELL, F. D., President, Kansas State Agricultural College, Manhattan, Kans. R. A. Seaton, L. E. Conrad.

FISHMAN, SOLOMAN, Instructor in Electricity, Newark College of Engineering, Newark, N. J. J. Ansel Brooks, James C. Peet.

GRINTER, LINTON E., Associate Professor of Civil Engineering, A. & M. College of Texas, College Station, Tex. F. C. Bolton, J. J. Richey.

HESSLER, VICTOR P., Instructor in Electrical Engineering, Iowa State College, Ames, Iowa. Fred A. Fish, J. K. McNeely.

HITCHCOCK, LAUREN B., Associate Professor of Chemical Engineering, University of Virginia, University, Va. J. L. Newcomb, W. S. Rodman.

JETT, DANIEL B., Assistant Professor of Civil Engineering, New Mexico College of A. & M. Arts, State College, N. M. R. W. Goddard, C. V. Mann.

JOHNSON, FREDERICK M. G., Professor of Inorganic Chemistry, McGill University, Montreal, Canada. S. A. Murray, H. M. MacKay.

LAMBERTINE, JOSEPH A., Instructor in Mechanical Engineering, Polytechnic Institute of Brooklyn, Brooklyn, N. Y. E. J. Streubel, H. P. Hammond.

LEONARD, SAMUEL J., Assistant Professor of Civil Engineering, Drexel Institute, Philadelphia, Pa. H. L. Bowman, R. C. Disque.

LOWE, THOMAS M., Instructor in Civil Engineering, University of Florida, Gainesville, Fla. J. R. Benton, W. S. Perry.

MCLAUGHLIN, DONALD H., Professor of Mining Engineering, Harvard Engineering School, Cambridge, Mass. H. J. Hughes, G. M. Fair.

MACDOUGALL, CHARLES W., Assistant Professor of Mining Engineering, Lafayette College, Easton, Pa. L. B. Plank, D. B. Prentice.

MAYER, ERNEST J., Assistant Professor of Mechanical Engineering, Colorado Agricultural College, Ft. Collins, Colo. L. D. Crain, E. B. House.

MUNRO, RONALD J., Instructor in Mechanical Engineering, University of Akron, Akron, Ohio. Fred E. Ayer, T. L. McJoynt.

NIMS, ALBERT A., Associate Professor of Electrical Engineering, College of Engineering, Newark, N. J. J. C. Peet, J. A. Brooks.

NOLLAU, LOUIS E., Professor and Head, Department of Drawing, University of Kentucky, Lexington, Ky., W. E. Freeman, C. C. Jett.

OLIVER, WILLIAM A., Instructor in Civil Engineering, Case School of Applied Science, Cleveland, Ohio. F. H. Neff, T. M. Focke.

PUCHSTEIN, ALBERT F., Associate Professor of Electrical Engineering, The Ohio State University, Columbus, O. F. C. Caldwell, J. E. Shepardson.

RAYMOND, BROTHER, Instructor in Civil Engineering, Manhattan College, New York City. John F. Furia, H. P. Hammond.

ROSE, FRANKLIN O., Instructor in Engineering and Mathematics, Modesto Junior College, Modesto, Calif. J. C. L. Fish, E. C. Thomas.

UPP, CLARENCE R., Assistant Professor of Mechanical Engineering, University of Akron, Akron, Ohio. Fred. S. Griffin, Fred E. Ayer.

WELLS, ARTHUR E., Professor of Metallurgy, Harvard Engineering School, Cambridge, Mass. H. J. Hughes, H. E. Clifford.

WINKFIELD, HOLLEY S., Assistant Professor of Electrical Engineering, Northeastern University, Boston, Mass. F. A. Stearns, H. B. Alvord.

Total new members 85

THE 1929 MEETING OF THE SOCIETY.

The thirty-seventh annual meeting of the Society will be held at The Ohio State University, Columbus, Franklin County, Ohio, Wednesday, June 19, 1929, to Friday, June 21, 1929, inclusive. The Program Committee is working on the program and expects to have a preliminary copy in the hands of all members about April 15.

DATE OF 1929 CONFERENCE ON MECHANICS

The Conference on Mechanics to be held in connection with the Annual Meeting of the Society at Columbus, Ohio, will begin its sessions on Saturday, June 22, immediately following the close of the annual meeting and will continue until June 27, closing in time to accommodate those who are planning to attend the Summer School on Mechanical Engineering, which begins at Purdue University on the latter date.

SECTIONS AND BRANCHES

After several sessions devoted to discussion, the January 7th meeting of the **Newark College of Engineering Branch** of the S. P. E. E. adopted the following resolutions:

(1) Cooperative courses giving same degrees as purely academic courses should have approximately the same academic time content.

(2) Inasmuch as the term, "Semester Hour" is so vague due to variable class, day, week and semester periods, it seems advisable to use 1000 actual minutes of instruction as the "unit."

(3) On this basis, 165 "units" of academic work were deemed a good minimum requirement for a B.S. degree in any branch of engineering, at least 50 per cent of those "units" being in lectures and recitations, and the remainder in closely supervised laboratory work as distinct from cooperative work of any form.

(4) As the length of the cooperative period has a marked effect on the efficiency of instruction, it is considered fair to give one fourth time credit for cooperative work of periods of a month or less, and one fifth time credit for periods longer than a month.

DOUGLAS BAKER,
Secretary.

The winter meeting of the **Greater New York and Northern New Jersey Section** of the S. P. E. E. held its winter meeting at the Brooklyn Polytechnic Institute in Brooklyn, N. Y., on the afternoon and evening of December 8, 1928.

This was one of the most successful meetings yet held by this Section, attracting about one hundred and seventy-five to the afternoon meeting and almost as many to the evening dinner at which the Institute was the host.

Dean Arthur M. Greene, Jr., of Princeton, presided at the meetings as President of the Section and appointed committees on nominations, on resolutions, and on the question of extending the section.

The afternoon meeting aroused an unusual amount of interest and discussion.

Following the afternoon session, the Polytechnic Play Workshop put on a play under the title of "Brains," possibly a unique feature of S. P. E. E. meetings but one that was entirely acceptable. The opinion was expressed that engineering students evidently do not need to fear competition in the production of plays with students in other departments.

After the play, there was opportunity for an inspection of the Institute laboratories and for a social hour at the nearby Chamber of Commerce rooms.

The Institute provided an unusually fine dinner for its guests. Deane Greene presided at the after dinner exercises.

The New President of Stevens Institute, Dr. Harvey N. Davis was the guest of honor and the principal speaker. Others who spoke were Mr. Charles E. Potts, Chairman of the Corporation of the Brooklyn Polytechnic Institute; Dean R. L. Sackett of Penn State College, and Past President S. P. E. E.; Professor C. F. Scott, Yale University, Chairman of the Board of Investigation; and Mr. Hall who took the place of Dean Kimball of Cornell and President of the S. P. E. E., who was unable to be present.

The following resolution was unanimously adopted:

> The members of the Greater New York and Northern New Jersey Section of the Society for the Promotion of Engineering Education express their appreciation, and extend their hearty thanks to President Kolbe and the Faculty of Polytechnic Institute of Brooklyn for their hospitality on the occasion of the meeting, December 8th, 1928; to the speakers for their interesting and helpful addresses and to the Polytechnic Play Workshop for its delightful entertainment.

Action was taken by the meeting whereby the geographical

boundaries of the section will be increased to include a number of other institutions in eastern Pennsylvania, if it is found that these institutions desire to be included in the section.

The next meeting of the Section will be held at Stevens Institute, Hoboken, N. J., in the spring of 1929.

Professor H. P. Hammond of the Brooklyn Polytechnic Institute and Associate Director of the S. P. E. E. Investigations, was elected President.

Professor E. H. Rockwell of Lafayette College was re-elected Secretary.

EDWARD H. ROCKWELL,
Secretary.

Fifty-three teachers representing Ohio Institutions concerned in engineering education attended the seventh annual meeting of the **Ohio Section,** held at Case School of Applied Science, Cleveland, the afternoon of May 11 and the forenoon of May 12. At the opening session, after the address of welcome by Dr. Charles S. Howe, President of Case School of Applied Science, W. E. Wickenden gave an informal account of the new investigation under the auspices of the Society, and outlined some of the proposed projects. Then, members of the summer schools of Mechanics in 1927 discussed the activities in these schools and the value of such summer study. At the close of this session, members of the Case Student Branch of the American Society Mechanical Engineers acted as guides for the inspection of the Charles William Bingham Mechanical Engineering Building and The Worcester Reed Warner Laboratory of Hydraulics and Mechanics. These laboratories have been designed to meet changing conditions in the field of engineering. The equipment is new and many interesting features have been incorporated in the design. In the evening, the members of the section were guests of the Engineering Department of The National Lamp works. Here, after an informal dinner, and a visit to the Nela School of Lighting, Mr. Ward Harrison, Director of Illuminating Engineering of the National Lamp work gave a lecture on *Artificial Lighting.*

The second session was given over to round table discussion of some points brought out by Mr. Wickenden's talk at the first session, and to the report of Professor V. B. Caris, Ohio State, on the status of mathematics in pre-college training. All the discussion was pertinent and stimulating, and evidenced careful thought on the aims and problems of engineering education as they have been brought forth by the investigation, and an enthusiastic desire to participate in the activities of the local section and of the society at large. The officers of the sections for the year are: Chairman, Phillip C. Nash, Antioch; Vice-chairmen, James E. Boyd, Ohio State; J. B. Brandeberry, Toledo; Secretary, S. A. Harbarger, Ohio State.

S. A. HARBARGER,
Secretary.

The **South Dakota Section** of the S. P. E. E. met in Huron, S. D., Friday, January 11, 1929, on the day following the annual meeting of the Society of Architects and Engineers. The morning session was devoted to the topic, "The Relation of Engineering Colleges to the Industrial Development of South Dakota."

The afternoon session considered the problems of vocational information for prospective engineering students.

The State College of Agriculture and Mechanic Arts had three representatives, including Dean H. M. Crothers, President of the Section. The State School of Mines had three representatives, including President O'Harra and the Vice-President of the Section, Prof. J. O. Kammerman. The University of South Dakota had seven representatives. Three prominent city superintendents of the state were present during the sessions and took an active part in the discussions. Also some of the architects and engineers of the state, who remained over after their own meeting, attended our sessions.

The title of President Crothers' presidential address was, "High School Instruction in Mathematics for Engineering Students." Dean Crothers stressed the importance of a radical change in the method of instruction as a student passes

from arithmetic into algebra. This change in method should consist of an insistence upon an understanding by the student of the reasons for every algebraic process. That algebra, to be of any value to a student as an engineer, should be preeminently a reasoning process and not a merely formal one was the contention which Dean Crothers maintained with effectiveness.

The discussion of the industrial development of South Dakota demanded much interest in the meeting of the Section, just as it has been the leading question in the state at large for about a year.

Mr. J. H. Clause of the Washington High School of Sioux Falls gave a talk, "On the Value of the JOURNAL OF ENGINEERING EDUCATION to the High School Instructor." Mr. Clouse stated that he had found the JOURNAL OF ENGINEERING EDUCATION of very great value to himself as a teacher of physics. This may be just a passing phase in the character of the Journal. He referred to a number of articles among which was A. E. Kennelly's article on the "Historical Outline of Electrical Units." Mr. Clouse said that the JOURNAL OF ENGINEERING EDUCATION had been of decided value to other members of the high school faculty in the way of helping them to give vocational information to high school students. The Washington High School has in its faculty four graduates in engineering. Therefore, we would expect more interest in the question of vocational guidance for prospective engineering students in this high school than would generally be found.

The South Dakota Section of the S. P. E. E. feels that the activities of the Educational Departments of the Universities has had a tendency to create in the minds of high school men the idea that if they are proficient in educational science they need not be so much concerned about their knowledge of science and mathematics. The South Dakota Section desires to emphasize in the minds of high school teachers, superintendents, and instructors, the importance of a high standard of scholarly qualifications, outside the field of educational science, and the Section realizes that this project is big enough to occupy its attention for some time.

The Section ratified nominations made by the committee, electing the following officers: President, Prof. J. O. Kammerman of the State School of Mines; Vice-President, Dean L. E. Akeley of the University of South Dakota; Secretary-Treasurer, Prof. H. S. Carter of the State College of Agriculture and Mechanic Arts.

L. E. AKELEY,
Secretary.

COLLEGE NOTES

Carnegie Institute of Technology.—A bronze memorial tablet in honor of the memory of Dr. Arthur Arton Hamerschlag, first president of the Carnegie Institute of Technology, was unveiled at the annual celebration of Carnegie Day held at the institution on November 27. The tablet was unveiled by Dr. F. P. Keppel, president of the Carnegie Corporation of New York, and is now placed permanently in the main corridor of Administration Hall. Barthold Nebel, of New York, former head of the Department of Sculpture of the Carnegie Institute of Technology, was the designer.

President Thomas S. Baker underwent an operation at Johns Hopkins Hospital, Baltimore, during the Christmas Holidays following an attack of influenza. He is reported to be making satisfactory progress toward recovery.

Successful purification of manganese by distillation recently has been achieved as a result of research work conducted by Dr. F. M. Walters, Jr., director, and Drs. V. N. Krivobok and J. B. Friauf, associates, of the bureau of metallurgical research, Carnegie Institute of Technology. Metals of low melting points such as mercury, cadmium and zinc have been purified by distillation but manganese with its comparatively high melting point, 1244 degrees Cent., has presented a more difficult problem. The purified metal will be used by the bureau of metallurgical research in a comprehensive study of the iron-manganese-carbon system.

The new course in aeronautical engineering, established as an option this year in the department of Mechanical Engineering, has an enrollment of 32 sophomores. Equipment received since the course was opened in September includes a hydroplane presented by Col. Harry Fry of Pittsburgh, and a Liberty motor loaned by the U. S. Government. It is planned to install a closed circuit five-foot wind tunnel for

instructional purposes in the near future. Assistant professor A. H. Blaisdell is in charge of the course.

The total enrollment this year, exclusive of summer students of 1928, is 6373. Of these 2454 are regular day student registrations, 3594 are night school registrations, 158 are enrollments in part time classes, and 167 are Saturday Morning Class students.

Registration in the College of Engineering is 583 in the day courses and 926 in the night classes.

Case School of Applied Science.—On November 16, 1928, the Case Chapter of the Society for the Promotion of Engineering Education met to hear President Chas. S. Howe explain the purpose, ways, and means of successful teaching. Professors Boylston, Dates, and Zimmers also expressed several ideas and instances of effective teaching and its reward.

At the beginning of the school year there were seven new appointments to the Case faculty. They were Dale D. Frantz, Harvard, Instructor in Mathematics; B. C. Getchell, Colby, Instructor in Mathematics; E. J. Falkenstein, University of Illinois, Instructor in Economics; Wm. A. Oliver, University of Illinois, Instructor in Civil Engineering; C. V. Bertsch, University of Michigan, Instructor in Physics; M. B. Wright, Cornell, Instructor in Mechanical Engineering, and A. A. McCarvel, Instructor in Pattern-Making.

At the same time a new course in Business Finance was added to the curriculum by Dr. Frank Carlton, professor of Economics, because of the insistent demand for such courses for technically trained men.

Soon after the beginning of the school year three instructors were promoted by the Case Board of Trustees. Mr. Malcolm Stuart Douglas, Instructor in Civil Engineering, a graduate of the University of Wisconsin; Mr. Russell Caldwell Putnam, Instructor in Electrical Engineering, graduate of Butler College and the University of Colorado; and Mr. Herbert Robinson Young, Instructor in English, graduate of Denison University and Columbia University were made Assistant Professors of their respective departments.

Professor Fred L. Plummer has recently been retained by Wilbur Watson and Associates to act with Professor George E. Beggs of Princeton University as consultant on the design of the Zeppelin Corporation at Akron, Ohio.

For the past several months Professor Plummer has been devoting his time to the design of the proposed Lorain-Central Avenue High Level Bridge in Cleveland.

On June 27, 1928, word was received of the death of Dr. Cady Staley, first President of Case Schol of Applied Science. Dr. Staley, who died at the age of 88, came to Case as president in 1886. Before that the school had no acting head. In 1902 he resigned and devoted his time to travel and study. Three weeks after he became president the only building Case then had was destroyed by fire, with a loss of $150,000. Dr. Staley asked aid of Adelbert College of Western Reserve University and was offered the use of its dormitory in which to carry on classes. Following the fire, Dr. Staley devoted himself untiringly to development and physical expansion at Case. After experience in the west as an engineer for the Southern Pacific Railroad, Dr. Staley came to Case as president and professor of Civil Engineering.

Three members of the faculty who served under Dr. Staley are still teaching at Case. They are Dr. Frank Comstock, head of the Descriptive Geometry and Drawing Department; Dr. Dayton C. Miller, head of the Department of Physics; and Professor Frank H. Neff, head of the Civil Engineering Department.

On November 16, 1928, President Charles S. Howe announced a loan fund for Case students amounting to $107,000 left by the late Dr. Cady Staley. The income of this fund is to be loaned to worthy and needy students to complete their engineering education.

An organization recently started at Case is the Aero Club. The purpose of this club is to organize the students who are interested in aeronautics. Once every month the aero club has a man who is an expert in some branch of aeronautics speak before them and so widen their knowledge of the subject.

Last summer a new building was finally equipped for use at Case. This is the Warner Laboratory of Mechanics and Hydraulics and is the home of the Mechanics Department, headed by Professor Danforth. The building has on the first floor seven machines for testing materials which range from two hundred thousand pounds per square inch down to a wire testing machine. On the same floor is a modern cement laboratory. The second floor has the offices of the members of the department and apparatus for the testing of hardness materials. The third floor is divided entirely into classrooms.

President Howe states in his recent article on "College Teaching as a Profession" that the graduates of engineering colleges generally receive a higher salary than the professors who taught them, but at the present the salary of professors is much better than ever in the past and conditions are constantly improving.

At the meeting of the Case School Board of Trustees in October, full professor's salaries were raised to a maximum of $6,000, associate professors to $4,000, assistant professors' salaries to $3,300, and instructors receive $1,800 to $2,500, depending upon their experience and time with the school.

Clemson College.—The following faculty changes occurred in the Engineering Department of Clemson College (The A. & M. College of South Carolina) at the beginning of the present school year:

1. Mr. E. L. Carpenter, formerly Associate Professor of Mechanical Engineering, has been succeeded by Mr. Bernard B. Betty, formerly of Vanderbilt University. Professor Carpenter is now at the University of Tennessee.

2. Mr. John A. Hartell, Instructor in Architectural Drawing, has been succeeded by Mr. R. L. Anderson, Associate Professor of Architecture and formerly of Princeton University.

The Engineering Department, following the destruction by fire of its old quarters in May, 1926, is now completely housed in new buildings. All shop courses are now conducted in the new shop building, built and equipped during the 1926–1927

session and all the remaining courses and laboratories are housed in the new main engineering building, built during the 1927–1928 school year. Certain laboratory equipment and machines are still in process of being installed in the latter building.

On November 23d, 1928, the South Carolina Alpha Chapter of Tau Beta Pi was established at Clemson College. Following the repeal two years ago, of the state law prohibiting secret societies in the state schools of South Carolina, a local honorary engineering society, drawing its membership from the upper fifth of the class, was formed at Clemson. This local society was granted a charter by Tau Beta Pi when the latter society held its national convention in St. Louis, early in November.

Professor R. C. Matthews, of the University of Tennessee, National Secretary-Treasurer assisted by five student delegates from the Georgia Tech Chapter, headed by their president, Mr. S. A. Cannon, together with Professors Clarke, Tucker and Stevenson of the Clemson Faculty, conducted the installation and initiation. Among the alumni initiated at this time were Professors Rhodes, Freeman and Sams for Clemson College and Professor Earle, Director of Engineering at Clemson, for the Cornell University Chapter.

University of Hawaii.—The total enrollment this year in civil engineering is 55, while the enrollment in the College of Applied Science is 276.

The installation of measuring tanks, weirs and storage facilities in the new hydraulic laboratory will be completed by February first and the laboratory will be available for instruction and investigation during the second semester.

The short course for plantation men interested in irrigation was given in December. Prof. H. A. Wadsworth was in charge and was assisted by other members of the faculty. 30 men were enrolled for the course.

In order to allow practicing engineers as well as seniors to take the course in soil mechanics, it is being given in the evening. The laboratory has been fully equipped with the latest

apparatus for investigation in this science. The enrollment for this work numbers 28.

Prof. C. B. Andrews has resumed his work after a year at M. I. T., where he took graduate work, mostly in the line of Soil Mechanics.

Lehigh University.—The current academic year at Lehigh University has been marked by a number of changes, both in equipment and personnel. The most outstanding physical improvements are the construction of the James Ward Packard Laboratory of Electrical and Mechanical Engineering, and the new University Library.

The Packard Laboratory is the result of a gift of $1,200,000 by the late James Ward Packard, class of 1884, founder of the Packard Motor Company. Begun in April, 1928, construction has progressed so rapidly that it is expected that the Packard Laboratory will be ready for occupancy about May first. The word "laboratory" is here used in a broad sense, for the new building will house completely the departments of electrical and mechanical engineering. It therefore includes classrooms, staff offices, a central auditorium, two lecture halls with demonstration tables and adjoining apparatus rooms, shops and finally the engineering laboratory itself.

The laboratory proper, divided equally between the two departments, is a single room 60 ft. by 225 ft, with a ground floor, a main floor and a gallery. Natural lighting is obtained through windows on all sides and through a central skylight of the monitor type which runs the entire length of the laboratory. The entire building is symmetrically disposed about a central axis, with the laboratory running completely across the rear of the building at right angles to the axis. In harmony with the Alumni Memorial Building and the new library, the exterior walls of the Packard Laboratory are of native stone trimmed with cut limestone. The first Packard automobile will be displayed permanently in the main lobby of the building.

Long ago outgrown, the present Lehigh University Library is being enlarged by a $600,000 "extension" which all but

surrounds the original building and which to all intents and purposes is a new library in itself. The present building, whose floor area is but one-fifth of the ultimate total, is to be used principally for stack rooms. A large new reading room and several smaller rooms will increase the seating capacity from 50 to 400. This is considered adequate for a college the size of Lehigh, with 1500 students and about 170 faculty members. At present, the stack rooms are crowded to capacity with 180,000 books, but when the extension is finished there will be shelves for over half a million volumes.

In planning the new library, special attention was paid to the location of catalog rooms, librarian's offices, etc., with a view to efficient administration. Besides the main reading room there will be a "treasure room," a room for the "Lehigh collection" of material pertaining to the college and its alumni, an art room, a map and chart room and the usual seminar rooms. An especially interesting room, with about fifty seats in it, is to be known as the "browsing room." This will be furnished more like a club room than like the conventional reading room, and is designed to encourage general reading among undergraduates. Here the student may smoke and browse to his heart's content among the "best books" bearing no particular reference to class room work. It is believed that such a room will be as popular and valuable at Lehigh as it has proven in other colleges.

Lehigh University has just published a booklet entitled, "How About Engineering?" Written in the form of a catechism, this booklet attempts to answer the questions that arise in the minds of prospective engineering students. Engineering and its principal subdivisions are defined and the work and qualifications of the engineer briefly outlined. An S. P. E. E. table, "Analysis of Earnings of Engineering Graduates," is used to illustrate the opportunities that await the young engineer. The booklet closes with information pertaining in particular to the Lehigh engineering courses.

The present undergraduate registration at Lehigh is 1477, as compared with 1511 in 1926 and 1515 last year. The

slight decrease is mainly in the colleges of arts and science and business administration.

Massachusetts Institute of Technology.—The Cooperative Course in Railroad Operation is one of the most recent courses started at the Institute. This course is to be operated in conjunction with the Boston and Maine Railroad on exactly the same schedule and educational principles as the Cooperative Course in Electrical Engineering, which has been in successful operation for the last ten years.

The Dramashop, under the direction of Professor D. M. Fuller, of the Department of English and History, is now in its second year, and is busy working up its fourth play, "The Lower Depths," by Maxim Gorky. Former productions are "The Hairy Ape," by Eugene O'Neill, "At the Sign of the Green Pig," by Charles S. Brooks, and "The Show-Off," by George Kelly. By choosing plays of such widely different types, the Dramashop offers opportunities to Tech men to study stage lighting effects, scenic construction and business management, as well as play acting. It is too early to predict the future of this venture, but already it has been proven that Tech students are as interested as Liberal Arts students in the problems of dramatic production.

Professor Reinhold Rüdenberg, Chief Electrical Engineer of the Siemens-Schuckert Works in Berlin, and Honorary Professor of Electrical Engineering at the Technische Hochschule in Charlottenburg, was in residence at the Institute for the month of February, and delivered a series of ten lectures on the theory of Transients and Travelling Waves and their effects on transmission lines and electrical machinery. Not only did these lectures stimulate a lively interest in the subjects which he covered, but his residence at the Institute afforded opportunity for informal conferences upon various research problems and numerous projects of common interest.

University of Michigan.—A course in bituminous materials and bituminous pavements was given during the Christmas vacation which included 30 hours of classroom work and 12

hours of laboratory practice. Three hours each day were devoted to lectures and recitations.

In addition to undergraduates and graduate students in the University, the course was attended by several city paving engineers and material men.

No university credit was given.

In the College of Architecture there was shown in December a collection of about one hundred and fifty photographs and some drawings, illustrating the development of reinforced concrete in Europe and in this country. This exhibition brought out the wide range of application of the material, and the influence of sound technical design on architectural and decorative form. The use of concrete for garden objects and in sculpture was also demonstrated.

The January exhibitions in the Architectural Building consist of a collection of figure sculpture marble, wood, and bronze, by American artists, and a collection of block color prints by Elizabeth Keith, an English artist.

Professor W. S. Evans, Assistant Professor of Civil Engineering at the University of Maine, is engaged in research work in the Department of Transportation at the University of Michigan during his sabbatical leave.

The Michigan Engineering Society held a Testimonial Dinner in Grand Rapids February first in honor of Professor Henry E. Riggs, who has retired from active service in the University.

Missouri School of Mines and Metallurgy.—C. V. Mann, professor of engineering drawing, is on sabbatical leave for the school year 1928–29, studying toward his doctor's degree at the University of Iowa. Professor Mann will base his year's work at Iowa on the research work he has done in engineering education at the Missouri School of Mines during the last four years. A special part of his program will be the study and further development of objective type tests in engineering drawing and descriptive geometry, such as has been used with considerable success in the Drawing Department of the School of Mines the past year. The project upon which Professor

Mann is entering is considered by engineering educators as a radical departure from orthodox methods of training engineering teachers. This is one of the first, if not the first, venture of the kind undertaken in this country.

The registration at the School of Mines and Metallurgy this year has reached a total of 526, the largest in the history of the school. The largest increase was in the freshman class, which this year totals 212 registrants.

C. E. Bardsley, assistant professor of civil engineering, has been appointed to the Freeman Traveling Scholarship for the study of European hydraulics by the American Society of Civil Engineers. Br. Bardsley sailed for Germany the latter part of September to take up his duties. He was granted leave of absence by the school for that purpose.

W. D. Turner has been granted a second year's leave of absence from his duties as head of the department of chemistry, and will continue his work in New York. Dr. W. T. Schrenk will serve as acting head of the chemistry department during the present school year.

J. Bridge, associate professor of geology, has been granted sabbatical leave to do work toward his Doctor's degree at Princeton.

P. A. Willis, associate professor of mechanical engineering, has returned to the School of Mines, after a year's absence.

H. E. Ahrens has been appointed instructor in drawing. E. L. Peterson has also been appointed instructor in the drawing department.

Dr. O. R. Grawe, who has been on the faculty of the Mackey School of Mines at Reno, Nevada, has been appointed assistant professor of mineralogy here.

To the engineering faculty of **Northeastern University** have been added the following members: A. Arthur Capone, formerly of the Personnel Research Division of William Filene's Sons Company, Associate Professor of Psychology; James G. McGivern, Instructor in Drawing; Andrew H. King and Verner O. Nelson, Co-ordinators; and Rudolph O. M. Oberg, Assistant Co-ordinator.

The enrollment in the School of Engineering for the current year totals 1,634, divided by classes:

Seniors	266
Juniors	362
Sophomores	424
Freshmen	582

Letter grades in preference to numerical have recently been adopted by the Faculty to overcome certain features of percentage grades considered as unsatisfactory. It is admitted that letter grades do not entirely eliminate these features, but it is felt that they tend to minimize them. The system adopted is as follows:

A—superior attainment
B—above average attainment
C—average attainment
D—lowest passing grade
F—failure, but with greater effort and further study would probably pass. This grade permits clearing by a condition examination.
FF—complete failure, requires that course be successfully repeated in class.

The equivalents might be expressed in percentages as follows, although this practice is to be discouraged:

A = 90 - 100
B = 80 - 90
C = 70 - 80
D = 60 - 70
F = 40 - 60
FF = 0 - 40

Briefly stated, the reasons for adopting the letter grades in preference to the numerical were: (1) to take the emphasis away from grades, (2) to overcome as much as possible inaccurate and unjust grading, (3) to eliminate the granting of special privileges to men having failures on the basis of the degree of failure, (4) to eliminate in so far as possible

questions concerning the propriety of a grade, (5) to make for economy of time in coming to a decision in grading.

For determining those entitled to honors or for purposes of finding averages the following equivalents were adopted which are very similar to those employed by the University of Maine:

A an equivalent of 4
B = 3
C = 2
D = 1
F = 0
FF = −1

The last equivalent is used in order to prevent interpretation of any failure as a positive quantity.

Averages are then obtained as usual by direct averaging of the equivalent values. Honor requirements can be set at a certain numerical value, with certain low grades automatically eliminating a student from consideration, irrespective of his numerical equivalent.

Ohio State University.—Wiliam D. Turnbull, Professor of Engineering Drawing, has been appointed Junior Dean of the College of Engineering. In this position, he is adviser to freshmen and sophomores in regard to courses of study and academic progress.

The Nichols Medal of the American Chemical Society has been awarded to Dr. William Lloyd Evans, Chairman of the Department of Chemistry, for his contributions to the chemistry of carbohydrates.

The experiment in cooperative teaching of chemistry to first-year students entering with one unit of credit in high school chemistry—a brief account of which appears in *The Journal of Chemical Education*, September, 1928, pp. 1133–1135 is being successfully carried on again during the Winter Quarter. Members of the departments of mineralogy, physics and English as well as of the divisions of physical chemistry and of general chemistry have cooperated in the undertaking.

A cooperative short course in Concrete was given on the

Campus, January 21 and 22 under the auspices of the College of Engineering by Professor J. R. Shank, Department of Civil Engineering, Mr. J. M. Weed, Engineering Experiment Station and Mr. J. W. Kelley, Portland Cement Association. The topics discussed were *Theories of Proportioning, Bulking of Aggregates, Demonstration of Mixes, Water-Cement Ratio on the Job, Field Control Methods, Durable Concrete.* One hundred twenty-five practicing engineers engaged in railroad, city and county work, contractors, and material men were in attendance.

The total enrollment in the College of Engineering for the Autumn Quarter was 1555.

During 1928, The Engineering Experiment Station has published 10 bulletins and 3 circulars.

Regular courses in engineering subjects which affect the daily lives of the people of Ohio are given in the Engineering Experiment Station talks at 7:15 each Tuesday evening from the University Station, WEAO. There is also a series of talks on Thursday evenings at 8:15 consisting of material of engineering and general interest given by various members of the Engineering Experiment Station Staff, College of Engineering Faculty and others. On the third Thursday of each month, Junior Dean W. D. Turnbull and J. M. Weed describe through dialogue things of engineering interest seen on a trip to some nearby Ohio town. During the next few months talks are to be given on the studies in the engineering curriculum by members of the departments of English, drawing, chemistry, physics, mathematics, mechanics.

Under the supervision of Professor H. E. Nold, Department of Mine Engineering, 12 classes in Mining Vocational Education for fire bosses, mine foremen and miners have been organized in 12 mining towns in the state. Three hundred eighty persons have enrolled. A very concrete and definite two-year program has been worked out. This year the general fundamentals for mining, that is, elementary chemistry and physics, and mine gases and mine ventilation are being studied. Next year, the practical problems of mining are to be taken up.

Oregon State College.—Professor F. G. Baender, at one time head of the Mechanical Engineering Department of the University of Arkansas, and more recently designing engineer of the International Motors Company, has taken up his duties as head of the Mechanical Engineering Department. Professor Baender's first tasks have been to reorganize the Mechanical Engineering curriculum in minor detail, to plan the addition of equipment in the steam and gas laboratory, and to initiate extension courses in internal combustion engines in the City of Portland.

The common freshman year, which includes courses in engineering problems and drawing, has been reorganized both in its content and administration. The engineering problems work is directed upon the more simple fields of civil, mechanical, and electrical engineering paralleling the applications of mechanics, heat, and electricity in the subject of Physics, which the freshmen are taking simultaneously with it. The instructors are drawn from the degree departments and operate under the chairmanship of Professor G. W. Holcomb as a committee in the administration of the work. The results of training in engineering habits of work and thought and in orientation to the field of engineering and the curricula have been very satisfactory.

Mr. C. B. McCullough, State Bridge Engineer, has been added to the staff as part time professor of structural engineering and is teaching advanced work in this field. Mr. G. B. Herington, Executive Secretary of the Associated General Contractors, has also been added to the staff as a special lecturer upon engineering administration in construction. The courses offered by both of these men are proving of much interest to civil engineering students.

Apperson Hall, the second floor of which was formerly occupied by the Physics Department, has been vacated by them and has been remodeled for additional electrical engineering laboratories. A new standardizing laboratory, a new photometric laboratory, a new communications laboratory, and a large storage battery room have been added to the electrical

laboratories. These are rapidly being equipped and will be ready for use in the coming year.

Agricultural & Mechanical College of Texas, College Station, Texas.—New members of the teaching staff include: C. J. Finney, Professor of Architecture; D. L. E. Grinter, Associate Professor of Civil Engineering; J. A. Orr and T. A. Kelly, Instructors in Civil Engineering; Edgar W. Glenn, J. B. Dent, Instructors in Drawing; H. C. Dillingham, Associate Professor Electrical Engineering, in charge of Communication Engineering; W. D. Bliss, Professor and Head of Department of Mechanical Engineering, with R. M. Wingren, S. A. Witzel, instructors in the same Department.

The curricula of the Engineering courses have been modified by the elimination of some of the elementary shop work and the inclusion of a course in Engineering Problems throughout the freshman year. Professor C. W. Crawford of the Department of Mechanical Engineering has been placed in charge of this new course. In addition to the full time staff giving the work Professor Crawford has the assistance of certain designated members of the staffs of each of the engineering departments. This is resulting in a well rounded course which is basic for all the Engineering courses.

The Engineering Experiment Station is developing some interesting research work. Mr. J. A. P. Zellers, formerly with the Sewage Research of the Agricultural Experiment Station of New Jersey, has joined the staff of the Engineering Experiment Station and is devoting his time to research in sewage disposal.

The first unit of a new building for Chemistry and Chemical Engineering is under construction and it is expected to be ready for occupancy early in the summer. A temporary building has been erected for uses of laboratory in petroleum refining and is being fitted up with a complete refining equipment.

Tufts College.—A course in Aeronautics is being offered this year and has interested a considerable number of seniors. The history and construction of modern types of airships,

elements of aerodynamics, elements of design, and static and flying characteristics are included in the content of the course.

A recent textbook is that on Refrigeration by Moyer and Fittz. Professor Fittz has charge of the course in Refrigeration and his new book brings together the latest information on this subject. While intended primarily for instruction purposes in college classes, its arrangement is such that it is also useful for general reference. A special feature is the section devoted to household refrigerating devices.

A new cupola is being installed in the department's foundry and with other improvements already made will make it possible to handle work of commercial size.

The courses formerly known as Railroad Engineering and Highway Engineering have been combined into a single course under the title Transportation Engineering. It is felt that this will be an advantage because of the similarity and growing importance of the economic questions common to both subjects and the close relation of their engineering problems. By this change the time devoted to Sanitary Engineering can be extended to keep pace with the rapidly increasing development of this important field of the engineer's relation to Public Health.

A half year course in City and Regional Planning has been introduced. The tremendously rapid growth of problems concerning planning, in our cities and metropolitan regions has created a need for far sighted engineering study of the broadest character. The situation has gone much beyond the question of police control, and only comprehensive planning for future needs can save our cities and towns from the constant and expensive correction of mistakes, which they are now engaged in doing. It is engineering work of the highest order, and while it is not the aim of the course to train men for City Planning as a definite profession, it is expected to help the student to bear his part in a work which calls so largely upon the civil engineer and for so close a cooperation with the architect and the landscape architect.

The work of the Hydraulics Laboratory has been strength-

ened and the installation practically rebuilt, much work being done by the students themselves. New equipment includes a motor driven centrifugal pump, experimental propellor type, turbine for low head, pitometer, 2″–4″ and 4″–6″ Venturi meters, pulsometer, Pelton wheel, nozzles, weirs, gages, etc. Also a 3,600 R.P.M. 7½″ H.P. single stage high head pump is about to be installed.

The Electrical Engineering Department has added a new course in Communications to its curriculum. This course covers fundamental principles of both wire and space communication by means of voice or signal. Lecture and class room work is supplemented by an extensive Laboratory course, with equipment obtained in the last two years. Approximately $10,000 of this equipment represents contributions from industrial concerns.

Laboratory facilities in the Electrical Engineering Department have been augmented by a 200,000 volt, 100 kilowatt, high tension transformer. This equipment has been installed in a new fireproof laboratory, with special facilities for controlling of the apparatus and in the handling of tests. This equipment is used to supplement the regular laboratory work and for theses and research investigation.

The Chemical Department has been developing a new artificial stone. The laboratory experimental stage has been passed and in the shops of a local artificial stone manufacturer the production period has begun. Already this stone is being put in place in one of the suburban theaters.

Recently an interesting collection of mercury ores was sent to this laboratory for study and investigation. This work is going on. The results so far have been particularly gratifying to all concerned.

Another problem, still under investigation, relates to the absorption of various substances by commercial charcoals at low temperatures.

Among things not always found in chemical laboratories, installed here at Tufts is a set-up of platinum resistance thermometer and accessories. With this instrument under

proper working conditions small temperature intervals can be measured with an accuracy of 0.0005° C. The whole apparatus, standardized by the Bureau of Standards at Washington, provides here an ultimate standard for measurement of temperatures. Also, and through the generosity of the Elizabeth Thompson Science Fund, has been provided a Zeiss interferometer, by which the index of refraction of a liquid can be determined with the greatest known precision.

Virginia Polytechnic Institute.—Earle B. Norris, formerly Dean of Engineering of the Montana State College, has accepted the same position at V. P. I. Dean Norris assumed his duties in August, 1928, relieving Dr. Louis O'Shaughnessy, who had been acting Dean during the past year.

Dean S. R. Pritchard has relinquished his administrative duties, because of his health, but continues as head of the Department of Electrical Engineering.

Prof. J. B. Jones, of the Department of Applied Mechanics and Experimental Engineering, is on a leave of absence for the year and is pursuing graduate work at Cornell University.

Prof. J. F. D. Smith, of the Department of Graphics and Mechanism, is likewise on leave and is spending the year at Harvard University.

J. Elton Lodewick has been appointed Associate Professor in charge of the Department of Wood Technology. Dr. Lodewick comes from Syracuse University.

Prof. J. B. Whittemore, formerly at the Louisiana State University, has been appointed Professor of Ceramics.

Prof. C. H. Cowgill, formerly of the Iowa State College, has taken up his work as head of the newly-created Department of Architectural Engineering.

Other new appointments include F. F. Groseclose, B.S. (V. P. I.), Instructor in Experimental Engineering, and P. H. Barnes, Jr., B.S. (N. C. State College), Instructor in Civil Engineering.

Bulletin No. 4 of the Engineering Experiment Station, "A New Type of Gear Testing Machine," by Prof. Wm. H. Rasche and Asst. Prof. J. F. D. Smith, was issued in September.

Equipments are being installed for laboratories in ceramics and for rayon manufacture. The rayon laboratory is believed to be the first college laboratory in this comparatively new branch of the textile industry.

The Patton Hall of Engineering, which will become the principal building of the engineering group, is now completely enclosed and the contractors are doing the interior finishing.

University of Washington.—The plans of the building for the newly established Department of Aeronautical Engineering are at present in the hands of the donor, The Daniel Guggenheim Foundation for the Promotion of Aeronautics. It is expected that construction will be commenced in the very near future, and that the building will be ready for use at the beginning of the next school year.

A four-year course leading to the degree of Bachelor of Science in Aeronautical Engineering will be offered for the first time in 1929–30.

BOOK REVIEW

Problems in Alternating Current Machinery. By WALDO V. LYON. Second edition. McGraw Hill. Price $2.25.

The author has more than doubled the number of problems in the five chapters on machinery, while Chapter VI (Polyphase Circuits) and Chapter VII (Non-Sinusoidal Waves) have been omitted entirely. There is a total of 780 problems in the new book.

A new feature is introduced by placing at the end of the book Chapter VI which includes 62 examination questions. These questions are about evenly divided over the five chapters which now make up the book.

The data for some of the new problems which have been added are quite comprehensive. Actual figures have been obtained from manufacturing companies for one or more of each type of machine, *i.e.*, transformer, converter, etc. This fact should interest the student because the data come from real machines, and are not "cooked up" by some instructor.

The book should find application in the drill and study of the fundamental theory of alternating current machinery with seniors and graduate students in Electrical Engineering.

R. C. G.